



D7.2 Final Report on Evaluation

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“I enjoyed that I got to participate, share, get inspired, learn so much, communicate such interesting things, try new practices in class, challenge my views and learn from teachers and scientists.” (Greek primary school teacher)



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Executive summary

This report outlines the main findings of the [Space Awareness](#) project evaluation. Building on a [Theory of Change](#) approach using a set of pre-identified [intended participant outcomes](#), the evaluation effort was designed to help create a sustainable legacy that will long outlive the duration of the project. There were four key aims:

- Formative evaluation to shape the project's activities to ensure that they met the aims of the project and the audiences' needs, with a spirit of continuous improvement.
- Report and measure the impact of the project in a way that is consistent across all activities and paying particular attention to any differences associated with intended career choice, gender, ethnicity and socio-economic status.
- Provide evidence of the project's successes and areas for improvement and help communicate these findings to policymakers, funders and others working in science education and engagement.
- Establish a baseline dataset regarding existing attitudes and opinions towards space science, as well as developing an approach for determining longitudinal impacts of the programme in the future.

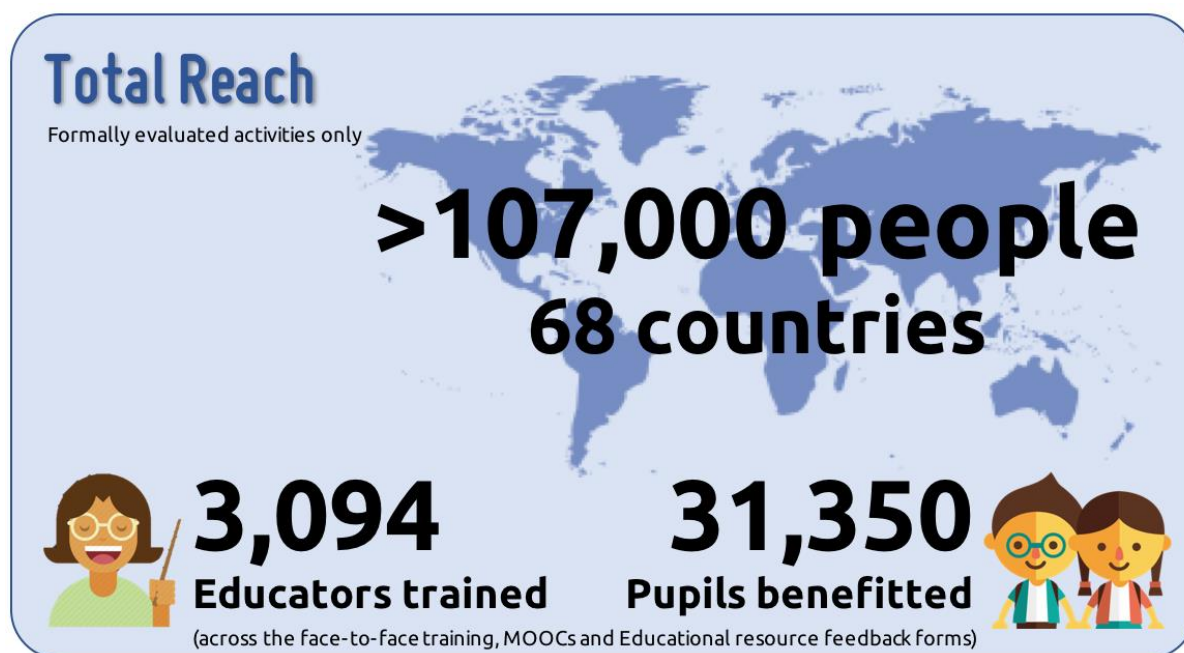
Our approach

Emphasis has been placed on school-aged students and school teachers, as this is where the bulk of the activity development and effort within the Space Awareness project was focused. Much of the evaluation data collection was conducted by the [project partners and dissemination nodes](#) as they distributed the Space Awareness resources to local teachers and other educators, based on protocols and tools developed within the [project evaluation framework](#). The combination of a centralised framework and distributed data collection has resulted in consistent and comparable data collected from across Europe and beyond regarding key activities such as the [Educational resources](#) for use by teachers in the classroom, [face-to-face teacher training workshops](#) and the [Massive Open Online Courses \(MOOCs\)](#). Additionally, a complementary qualitative fieldwork strategy, combined with dedicated online efforts and an [international teacher competition](#), allowed a more in-depth exploration of specific issues. For example, through these more qualitative approaches we were better able to investigate the impacts of the Space Awareness activities on specific target groups such as girls, ethnic minorities and those from socioeconomically disadvantaged backgrounds. Separate to the formal evaluation efforts, teachers and other educators were also provided with their own [assessment tools](#), consisting of both formative and summative techniques, to help assess pupil learning in engaging and informative ways. All evaluation procedures were conducted according to appropriate ethical guidelines.

This report synthesises the evidence collected in the various [individual activity reports](#) to identify over-arching patterns at a holistic project level in terms of reach, participation and perceived quality, and the project's successes in achieving the Space Awareness intended outcomes. For the benefit of future similar projects, strategic and practical recommendations have been developed based on the evidence from Space Awareness in order to inform future policy in space science education within Europe and beyond.

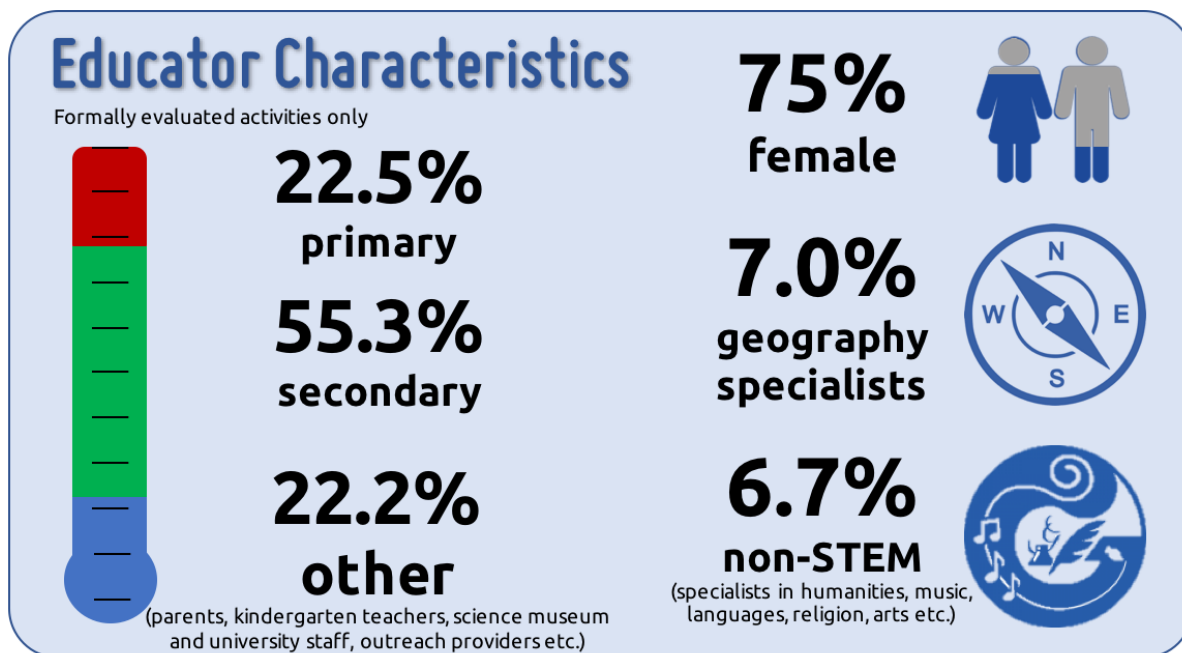
Participation

Overall, we have detailed evaluation evidence of the main Space Awareness activities having reached over 107,000 people throughout Europe and beyond. This included 3,094 educators who attended the teacher training workshops and MOOCs and/or trialed the Educational resources, as well as at least 31,350 pupils who directly benefitted from their teachers' implementation of Space Awareness activities within their classrooms. A further 8,283 pupils were also involved in completing the baseline pupil survey, which provides pioneering insights into European students' perceptions of space science.



There is no doubt that Space Awareness achieved a very wide area of influence, involving at least 68 different countries, including every member state of the EU except Luxembourg. Representation was particularly strong from southern and eastern Europe, and although there were some exceptions, in general there was a noticeable lack of participation from western European countries.

In terms of the educators who participated in the various evaluated activities, Space Awareness appears to have been very successful in reaching many of its key target audiences. **Primary school** teachers accounted for just over a fifth of the overall cohort, and there was good success in reaching out beyond traditional STEM (science, technology, engineering and mathematics) subjects: 7.0% of educators were **geography specialists**, whilst a further 6.7% were from **non-STEM backgrounds** (such as religion, history, languages and other humanities and arts subjects). The strong involvement of female teachers (approximately three-quarters of the overall cohort), and the frequent high ratings provided by females (see below) indicate that Space Awareness has made positive steps in **supporting female participation** in space science. It was also noticeable that the Space Awareness activities and resources tended to attract **highly experienced teachers**: for both the MOOCs and the teacher training workshops more than half the participants had taught for at least 15 years.



It proved impossible to accurately and reliably gauge socio-economic or minority status for the quantitative evaluation elements within the scope and resourcing of the present project (see section 2.2 of the main report for further details). However, the complementary qualitative fieldwork efforts provided evidence of key successes in **impacting positively on** girls as well as socio-**economically disadvantaged and/or minority groups**; specific Examples have been included as case studies throughout section 4 of the main report.

Key findings

The **overall ratings are extremely positive**: over 70% of respondents gave the top rating of “Very good” (or a score of 8, 9 or 10 for the Educational resources) for each of the main formally evaluated activities (the MOOCs, face-to-face training workshops and the Educational resources). This rose to 99.3% of combined “Good” or “Very good” for the teacher training workshops, and likewise 97.8% for the MOOCs. It is clear from these ratings that the resources and activities were overall received very positively, and were considered to be of high quality by those who accessed them. Indeed, converting the ratings to a 5★ average (where the lowest score is 1★ and the highest rating is 5★) shows that the average user rating for all three major Space Awareness activities was over 4★, reaching to more than 4.6★ for both the MOOCs and face-to-face teacher training workshops. Over 97% of participants indicated that they would recommend the course to a colleague, whilst 99% would participate in a similar course again themselves. Both these very high ratings are persuasive indicators that **participants valued the courses and felt they were worth committing the time and resource to attend**.

At least three quarters of people who tested an educational activity agreed or strongly agreed that the majority of the teacher-related intended outcomes had been achieved for them, rising to over 90% for aspects relating to the helpfulness of the content and extent of information provision. Statistical analysis also suggested that the educational resources were particularly effective in supporting primary teachers. This is excellent news for the Space Awareness project, as primary teachers were a key intended audience.



Compared to their wider cohorts, **geography** and **female teachers** attending the face-to-face teacher training workshops **provided particularly positive overall course ratings**, suggesting that they found the courses well-suited to their needs. Female MOOC participants were also statistically more likely than male participants to agree with the statement “I would like to participate in another similar course again” ($p=0.006$), suggesting that those courses achieved their aim of supporting women’s participation in space science.

Table 1 and Table 2 provide a visual summary of **which pre-identified intended learning outcomes were achieved within the Space Awareness programme**, categorised according to the main themes: *Feel, Value, Understand, Do* and *Skills*. The final columns serve as a “traffic light” indicator of the extent to which the evidence gathered supported whether each outcome had been achieved for each major area of project activity¹. Specific supporting evidence and case study Examples showcasing the richness of participant experience around key achieved impacts are also included in section 4 of the main report.

It is clear that there was strong evidence (albeit sporadic in places) that all of the intended outcomes were achieved within the Space Awareness programme. In brief: the Space Awareness activities were considered **interesting** and **useful** and participants also expressed a range of other positive emotions associated with their teaching and/or learning of space science. They reported **greater appreciation of the relevance and diversity of space science contributions** and **gained substantial factual knowledge** relating to the specific topics covered. The **interdisciplinary relevance of space science** was highlighted by many participants as one of the aspects they liked most about the activities and resources, and found most stimulating within many of the training sessions.

¹ In addition to teachers’ self-reported responses to direct statements (see section 4 of the main report), these judgements have been based on a synthesis of qualitative comments received. The key to the colour scale used is included at the bottom of the table.

Space Awareness Intended Outcomes		Space Awareness activities			
		Educational resources	Face-to-face training workshops	Teacher MOOCs	Competitions
<i>Priority outcomes are listed below; X indicates that outcome was a target for the specified activity. Grey writing indicates additional outcomes of slightly lower importance</i>					
Feel <i>Enjoyment, inspiration and creativity</i> = MAJOR PRIORITY CATEGORY					
Find Space Awareness activities interesting		X		X	
Enjoy learning/teaching about space		X		X	
Feel confident teaching space topics		X		X	
Feel inspired by space science		X	X	X	
Feel positive about space science		X	X	X	
Aspire to space science careers (students)		X			
Value <i>Values and attitudes</i> = MAJOR PRIORITY CATEGORY					
Value the diverse contributions of many different cultures to space science		X	X	X	
Value the contributions made by both women and men to space science		X		X	
Value trans-national European and Global citizenship		X		X	
Appreciate that space science contributes to everyday life		X		X	
Appreciate that school science is relevant to space science		X	X	X	
Appreciate that people who work in space science are real people			X	X	
<i>Strong evidence this outcome was achieved</i>	<i>Strong but sporadic evidence this was achieved</i>	<i>Some evidence this outcome was achieved</i>	<i>Evidence this outcome was NOT achieved</i>	<i>No evidence either way</i>	

Table 1 - Summary of achieved outcomes: Feel, Value²

There is no doubt that the majority of teachers were able to **access and use the Space Awareness activities confidently**, including adapting or creating their own related content, and that they – and their pupils – were inspired to learn more about space science. There was a real energy from both teachers and their students around **sharing** their improved understanding of (and enthusiasm for!) space science with others, including colleagues, friends, family and/or the wider community. Teachers also indicated that they had actively **encouraged their students to pursue careers** in space science or related areas, **especially girls and ethnic minorities**.

² Note that the “MOOCs” column incorporates evidence from both the survey data and a qualitative analysis of the *Navigation Through the Ages* MOOC, whilst the “Competitions” column combines international evidence from the pupil-oriented *Space Scoop Comic Contest* as well as the *Celebrating Excellent Space Science Teaching* competition. Blank boxes indicate outcomes that were not a focus for that activity.

Space Awareness Intended Outcomes		Space Awareness activities			
		Educational resources	Face-to-face training workshops	Teacher MOOCs	Competitions
<p><i>Priority outcomes are listed below; X indicates that outcome was a target for the specified activity. Grey writing indicates additional outcomes of slightly lower importance</i></p>					
<p>Understand <i>Knowledge and understanding</i></p>					
Highlights of space science (<i>Our Wonderful Universe, Our Fragile Planet and Navigation Through the Ages</i>)	X		X		
The impact of space science on society and everyday life			X		
Space science can be used for teaching in many disciplines including cross-disciplinary contexts and non-science subjects	X	X	X		
Space science career opportunities are diverse, rewarding and highly accessible (particularly to girls and ethnic minorities)		X	X		
Space science needs an interdisciplinary approach	X		X		
Space science is a global/European endeavour		X			
Career opportunities in space science and technology at all levels		X	X		
Relevant pathways to these career opportunities			X		
<p>Do <i>Action, behaviour and progression</i></p>					
Access and use Space Awareness activities confidently	X	X	X		
Create own content and additional activities on the same or related topics			X		
Want to learn more about space science	X		X		
Choose or consider choosing, or encourage others, to study and pursue careers in space science and engineering or science and engineering more widely, especially girls and ethnic minorities	X		X		
Share their understanding of space science and technology with learners, peers, family and/or their community	X		X		
<p>Skills</p>					
Learn how to carry out scientific or technical activities themselves	X		X		
Develop inquiry-based skills for teaching/learning about space science	X	X	X		
Learn how to use IT to teach/learn about space science	X	X	X		
Learn how to be more inclusive while teaching, particularly for girls and minorities	X	X	X		
<i>Strong evidence this outcome was achieved</i>	<i>Strong but sporadic evidence this was achieved</i>	<i>Some evidence this outcome was achieved</i>	<i>Evidence this outcome was NOT achieved</i>	<i>No evidence either way</i>	

Table 2 - Summary of achieved outcomes: Understand, Do, Skills²

The main skills-related areas of focus within the Space Awareness programme were also well covered: participants reported developing their skills in **inquiry-based learning, using ICT** to teach about space science and **inclusive teaching strategies**. Of particular note is that even teachers who were already familiar with some of these aspects reported having further developed their skills in these areas.

For the lighter green outcomes, there was again evidence that these were achieved, but either the corresponding numbers were comparatively small, or the evidence related to anecdotal feedback. For these reasons, we could not assume that such outcomes were representative of the cohort as a whole. In the case of the amber (orange) or grey coloured outcomes in Table 1 and Table 2, there was either no evidence either way, or the evidence collected was inferential rather than direct. We did not see any evidence that they were NOT achieved, but within the scope of the current evaluation we were not able to report on them further. In many cases (especially regarding careers aspirations) these outcomes will require further longitudinal follow up with teachers and pupils to ascertain their success.

The operation of the Space Awareness project was also considered from a holistic perspective in order to identify over-arching success factors, as well as the key challenges encountered, as listed below. See section 5 of the main report for further details.

Success factors for Space Awareness Challenges encountered by Space Awareness	
Outstanding quality of content	Limited uptake by some audiences
Innovative reach to diverse audiences	Devolved project delivery and strong reliance on good will
Support for women (and girls)	Adjustments to intended project plan
Specific strong demographic patterns	Aspects beyond the resourcing available / scope of the project
Project design and development	Specific perceived weaknesses at resource / activity level

Recommendations

There is no doubt that many young people throughout Europe and beyond were greatly inspired by their involvement with the Space Awareness programme. There is also evidence that it had a profound impact on their likely future aspirations and career-related decisions. Projects like Space Awareness also play a fundamental role in ensuring teachers remain up-to-date, effective and enthusiastic, and have a wide influence long after the project ceases. Such projects should continue to be funded. In particular:

- 1) Space Awareness itself offers a unique opportunity for robust longitudinal follow-up due to the development of a baseline of pupils' attitudes and experiences, as well as a cohort of 180+ educators located throughout Europe who have registered their contact details for potential follow-up work.
- 2) There appears to be a gap in current provision regarding offering international-level support to trainee and newly qualified teachers. Further opportunities to work with national-level teacher training / accreditation organisations would be particularly complementary to the audiences already reached within the programme.

Further more detailed recommendations are provided in section 5.3 of the main report for the purpose of informing the development of future similar programmes.

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1 Introduction

Professional evaluation ensures that the project resources and activities are relevant and applicable to the various target audiences. The evaluation work package within the Space Awareness project was designed to help create a sustainable legacy that will long outlive the duration of the project. In particular there were three main areas of focus:

- 1) Investigation of decision making relating to space and technical career choices to enable a baseline of existing attitudes to be determined.
- 2) Formative evaluation and piloting of materials to assist in ensuring the resources produced were of the highest possible quality.
- 3) Summative evaluation to provide clear indications regarding overall impact.

All evaluation procedures were conducted according to appropriate ethical guidelines, and with an emphasis on developing and maintaining suitable networks and contacts in order to be able to conduct further longitudinal assessments of the impacts of the Space Awareness programme in the future.

This document outlines the main findings of the Space Awareness project evaluation.

1.1 Project Background

A brief overview of the Space Awareness project is provided here in order to provide context for the evaluation reporting. For further information about the project see www.space-awareness.org.

1.1.1 Project Aims

- To help stimulate the next generation of European space-oriented engineers and scientists, particularly girls and ethnic minorities.
- To use the perspective of space and the Universe to broaden children's minds, develop a sense of European and global citizenship and foster tolerance for diverse culture.
- To help build the scientific and technological capacity of developing countries, particularly in Africa.

Particular attention was on girls, ethnic minorities and those from disadvantaged communities. Note that for the purposes of the evaluation work package, emphasis has been placed on school-aged students and school teachers (both primary and secondary level, and potentially including other outreach educators), as this is where the bulk of the activity development and effort within the project was focused. This target audience is of paramount importance to the fulfilment of the project goals since recent research suggests that teachers and the relationship that the young have with school science is a key factor in the choice of scientific careers in the future (Tytler & Osborne, 2012; Regan & DeWitt, 2015).

1.1.2 Purpose of the Space Awareness evaluation

Evaluation Aims

There were four key aims in relation to the evaluation work described within this Deliverable:

- Formative evaluation to shape the project's activities to ensure that they met the aims of the project and the audiences' needs, with a spirit of continuous improvement.
- Report and measure the impact of the project in a way that is consistent across all activities and paying particular attention to any differences associated with intended career choice, gender, ethnicity and socio-economic status.
- Provide evidence of the project's successes and areas for improvement and help communicate these findings to policymakers, funders and others working in science education and engagement.
- Establish a baseline dataset regarding existing attitudes and opinions towards space science, as well as developing an approach for determining longitudinal impacts of the programme in the future.

Determining Impact

In relation to the aims above, the Space Awareness evaluation included consideration of three key elements:

- *Reach*: the number and diversity of participants engaged in the project activities (with special attention to girls, ethnic minorities, and disadvantaged communities where possible).
- *Significance*: the changes (resultant "outcomes" of the project activities) that occurred in both the short-term and the long-term where measurable.
- *Process*: learning about how/why the audiences use resources to inform future activity.

Monitoring reach and process are fairly self-explanatory; however significance requires further delineation as outlined in section 1.3 below.

1.2 Scope and development of the Space Awareness evaluation

An overarching Evaluation Framework was developed during the early stages of the project, see [D7.1](#) for details. This framework provided a structure and systematic approach for the evaluation of the separate elements within Space Awareness, thus enabling a consistent and robust comparison of impacts across the individual project activities as reported here. Conceptually, the framework took a [Theory of Change](#) approach, based on a [set of intended project outcomes](#)³ agreed at the start of the project. These outcomes are described in detail in [D7.1](#), along with the relevant ethical considerations and intended work schedule for the

³ Due to the fundamental importance of these intended outcomes to the work described here, the final set of outcomes is presented again in section 1.3.

evaluation effort. D7.1 also outlined the intended methodologies, tools and protocols for both of the baseline attitude surveys, which were conducted at European level.

The other major component of D7.1 was a toolkit outlining the intended processes for evaluating the various individual elements of the Space Awareness programme, ranging from educational resources to face-to-face teacher training workshops to Massive Open Online Courses (MOOCs). In brief, the toolkit provided a series of surveys and other feedback mechanisms (based on the agreed intended project outcomes) that were in the main designed to be implemented by the network of partners and nodes responsible for disseminating the various Space Awareness resources. Liaison with the partner nodes emphasised the need for easily accessible, relatively rapid forms of data collection for implementation at local level, leading in the main to questionnaire formats and partner self-reflections. Robust reporting mechanisms were included in order for all the data to be returned to the central UCL team for subsequent analysis and reporting.

A complementary qualitative fieldwork strategy was also developed to allow a more in-depth exploration of specific issues within the final year of Space Awareness, for example the impacts of the Space Awareness tools on specific target groups such as girls and/or ethnic and religious minorities.

For each specific area of activity, a dedicated evaluation report has been produced, as listed below. The purpose of these reports was to identify what outcomes were achieved, celebrate any successes, recognise challenges that were encountered and inform the development of future similar activities. Each report also outlined the methodology involved, including full copies of the relevant evaluation protocols and tools. For the sake of brevity, the major findings have not been repeated here, however are available online via the following links:

[Space Science: The view from European school students](#)

A survey of European pupils' views of space science was conducted in 2016 and early 2017 as part of the Space Awareness project. This summary report provides an overview of the survey and its main findings, particularly with regard to age, gender and country. Additional details of the data and analyses are included in a [technical annexe](#).

[Looking Back: Space scientists' reflections on career influences, paths and choices](#)

Within this survey participants were asked to reflect retrospectively on what influenced their decisions relating to space and technical career choices. A total of 415 individuals working in space science from over 30 countries responded to our online survey, representing a wide range of backgrounds and roles. This report summarises the key findings, and pays attention to the timings and initial influences of respondents' interest in space science, as well as how that interest was maintained. There is also a section highlighting key patterns within their reported career paths, including how their career interests developed, and what choices and priorities were influential.

Inspiring the Educators: Summary of feedback relating to the teacher training workshops delivered by individual partners and nodes

34 teacher training courses were delivered between September 2016 and June 2017. Within this document the data collection and analysis procedures are explained, utilising both participant and workshop organiser perspectives, and focused mainly on questionnaire surveys. The main results are delineated according to the courses delivered, participant backgrounds, course ratings, outcomes achieved, and any evidence of the skills developed within the courses being embedded into the participants' ongoing professional practice. Finally, a series of recommendations are offered in order to inform the development of future similar training workshops.

Deep Impacts: A summary report of the evaluation findings from the Space Awareness Massive Open Online Courses (MOOCs)

The evaluation of the MOOCs combined detailed quantitative surveys (distributed pre-, post- and after a 2-month delay in order to explore likely impacts from the course) with an in-depth qualitative analysis of a single course, *Navigation Through the Ages*. (Full details of the latter analysis are available in the *Engaging Teachers* report indicated below.) Respondents' backgrounds and participation patterns are explored in depth within this report, including a remarkable 30% course completion rate (corresponding to approximately six times the international norm). The evidence relating to the very high perceived quality, and success in achieving all of the intended participant outcomes, is also presented. In particular, comparison of pre- / post- / delayed- survey responses enabled affirmation of distinct knowledge gains and key shifts in participants' attitudes, values, skills and behaviours which appear to be directly linked to the Space Awareness project.

Engaging Teachers: *Navigation Through the Ages* MOOC: Summary of qualitative evaluation via participant observation

Participant observation was used within the *Navigation Through the Ages* MOOC to augment the survey data and collect qualitative evidence in relation to the intended learning outcomes. Evidence was synthesised according to the major Space Awareness Intended Outcome themes: *Feel, Value, Understand, Do* and *Skills*. These data augment the findings from the aforementioned *Deep Impacts* report by adding images, statements, reflections and narratives to better reflect the participant voice within the evidence presented.

Educate & Inspire: Summary of feedback relating to the Space Awareness educational resources

Feedback was provided on 43 separate educational activities via 212 separate responses to an electronic questionnaire representing an excellent breadth of contributions across central, eastern, northern and southern Europe. This report describes the data collection methodology as well as the respondents' backgrounds. In addition to an overall rating, key quality indicators were used to evidence the

respondents' generally positive reception of the resources developed. Other indicator statements enabled evaluation of the project's success in achieving the intended outcomes for both teachers and students. Finally, specific recommendations are identified in order to inform the development of similar future projects.

[Winning Hearts and Minds: Highlights from pupil and teacher competitions run within the Space Awareness programme](#)

This document presents inspiring case studies demonstrating the wonder, enthusiasm, and fundamental benefits to participants' attitudes, values, knowledge, skills and behaviours as a result of their involvement in the Space Awareness project. Each easy-to-read case study presents a snapshot of what can be achieved by teachers and pupils across the world who were inspired by Space Awareness resources and activities.

[Networking Space: Analysis of online and social media traffic relating to the Space Awareness project](#)

Based on data collected using standard (free) analytics tools, the main trends regarding the [Space Awareness website](#) and [Facebook traffic](#) are outlined. This includes an overview of visitor usage patterns and demographics, evidence of the growth in participation over the project, and the reach and traffic flow.

[Voices of experience: Education practitioner conversations at the *Mission to Mars* Summer School Marathon Greece, 2 – 7 July 2017](#)

This report is designed to synthesise and reflect upon the experiences of practicing teachers and educators from across Europe. It is specifically designed to help contextualise the wider [evaluation](#) of the [Space Awareness](#) project resources and activities. The Space Awareness project targeted educators as users of project activities and resources and the conduits of change. This report explores some of the broader patterns from the point of view of educators as practitioners. They are the experts on the context they work within, and their voices are valuable evidence of the issues at stake. The key findings consider what works inside the classroom, what are the key challenges faced by teachers, and what networks, resources and/or continuing professional development opportunities are sought in order to support teachers within their professional practice.

Additionally, in the interests of supporting and inspiring teachers and other educators within the Space Awareness community, we also developed a series of [teacher assessment tools](#). Data from these were not reported back centrally but such tools were disseminated publicly for use by teachers in their own classrooms to evaluate the impacts of their efforts.

Finally, at every stage of the evaluation data collection we have invited participants to register their contact details for potential involvement in follow-up research at a later date. This pool of 188 registered participants from across Europe and internationally will enable dedicated longitudinal follow-up to occur in due course – a rare and highly unique feature of the Space Awareness programme.

1.3 Intended outcomes

The project-wide Intended Outcomes shown on the following page were developed by the evaluation leads (UCL) in close consultation with the wider Space Awareness consortium via a multiple-stage iterative process of revision and feedback. They deliberately draw on the overarching project aims as well as the main target audiences mentioned in section 1.1.1.

Note that for the purposes of this framework, 'participants' referred to the people using Space Awareness resources, which could include teachers and other educators, school-aged students, and members of the public. Additionally, not all outcomes were appropriate to all participants or all resources; a map of which resources⁴ targeted which outcomes is provided in Table 3.

⁴ The mapping covers the three main Space Awareness activities and resources which were evaluated both quantitatively and qualitatively: the Educational resources, the face-to-face teacher training workshops, and the Massive Open Online Courses (MOOCs).

As a result of Space Awareness, participants will:

Feel* <i>Enjoyment, inspiration and creativity</i>	Value* <i>Attitudes & values</i>	Do <i>Action, behaviour and progression</i>	Understand <i>Knowledge and understanding</i>	Skills <i>Skills</i>
<p>Activities are interesting</p> <p>Enjoy learning / teaching about space</p> <p>Confident teaching space topics</p> <p>Inspired by space science</p> <p>Positive about space science (and careers)</p> <p>Aspire to space science careers</p>	<p>Diverse contributions from different cultures to space science</p> <p>Contributions made by both women and men</p> <p>European and Global citizenship</p> <p>The contribution space science makes to everyday life</p> <p>School science is relevant to current space science</p> <p><i>Also:</i> People working in space science are 'real people'</p>	<p>Access and use Space Awareness activities confidently</p> <p>Create own related content and additional activities</p> <p>Want to learn more about space science</p> <p>Consider choosing, or encourage others to choose, to study and pursue careers in space or science and engineering #</p> <p><i>Also:</i> Share their understanding of space science with others</p>	<p>Highlights of space science content (3 themes)</p> <p>Impact of space science on society and everyday life</p> <p>Space science can be used for teaching many disciplines (cross-disciplines and non-science subjects)</p> <p>Space science careers are diverse, rewarding and highly accessible #</p> <p>Space science needs an interdisciplinary approach</p> <p>Space science is an international endeavour</p> <p><i>Also:</i> Career opportunities at all levels (including relevant pathways)</p>	<p>Carry out scientific or technical activities themselves</p> <p>Develop inquiry-based skills for teaching/learning about space science</p> <p>Learn how to use IT to teach/learn about space science</p> <p>Learn how to be more inclusive when teaching #</p>

Notes

- Key priority outcome categories are marked *
- 'Also' refers to aspects that were agreed to be slightly lower priority than the others listed here
- Shaded areas refer to teacher-specific outcomes
- Outcomes with a particular focus on girls, ethnic minorities and/or disadvantaged backgrounds are marked #
- 'Science' is intended to be very inclusive, incorporating technology, engineering, mathematics etc.

Space Awareness Intended Outcomes	Space Awareness activities		
	Educational resources	Face-to-face training workshops	Teacher MOOCs
<i>Priority outcomes are listed below; X indicates that outcome was a target for the specified activity. Grey writing indicates additional outcomes of slightly lower importance</i>			
Feel <i>Enjoyment, inspiration and creativity</i> = MAJOR PRIORITY CATEGORY			
Find Space Awareness activities interesting	X		X
Enjoy learning/teaching about space	X		X
Feel confident teaching space topics	X		X
Feel inspired by space science	X	X	X
Feel positive about space science	X	X	X
Aspire to space science careers (students)	X		
Value <i>Values and attitudes</i> = MAJOR PRIORITY CATEGORY			
Value the diverse contributions of many different cultures to space science	X	X	X
Value the contributions made by both women and men to space science	X		X
Value trans-national European and Global citizenship	X		X
Appreciate that space science contributes to everyday life	X		X
Appreciate that school science is relevant to space science	X	X	X
Appreciate that people who work in space science are real people		X	X
Understand <i>Knowledge and understanding</i>			
Highlights of space science (Our Wonderful Universe, Our Fragile Planet and Navigation through the Ages)	X		X
The impact of space science on society and everyday life			X
Space science can be used for teaching in many disciplines including cross-disciplinary contexts and non-science subjects	X	X	X
Space science career opportunities are diverse, rewarding and highly accessible (particularly to girls and ethnic minorities)		X	X
Space science needs an interdisciplinary approach	X		X
Space science is a global/European endeavour		X	
Career opportunities in space science and technology at all levels		X	X
Relevant pathways to these career opportunities			X
Do <i>Action, behaviour and progression</i>			
Access and use Space Awareness activities confidently	X	X	X
Create own content and additional activities on the same or related topics			X
Want to learn more about space science	X		X
Choose or consider choosing, or encourage others, to study and pursue careers in space science and engineering or science and engineering more widely, especially girls and ethnic minorities	X		X
Share their understanding of space science and technology with learners, peers, family and/or their community	X		X
Skills			
Learn how to carry out scientific or technical activities themselves	X		X
Develop inquiry-based skills for teaching/learning about space science	X	X	X
Learn how to use IT to teach/learn about space science	X	X	X
Learn how to be more inclusive while teaching, particularly for girls and minorities	X	X	X

Table 3 - Map of intended project outcomes to each of the main Space Awareness activities

2 Participant backgrounds

This section provides an overview of who participated in each of the main Space Awareness activities, exploring patterns in key factors such as gender, level of schooling and subject specialism. There is also a note on limitations we encountered in collecting some of these data, most importantly relating to teachers' reporting of minority status and gender backgrounds of their pupils.

2.1 Overall reach

Table 4 provides a summary of the participant numbers involved in the various activities that were formally evaluated⁵ within the Space Awareness programme. Note that these figures have been amalgamated to produce the overall average values presented in the [Executive Summary](#).

Overall, we have detailed evaluation evidence of the main Space Awareness activities having reached over 107,000 people throughout Europe and beyond. This included 3,094 educators who attended the teacher training workshops and MOOCs and/or trialled the educational resources, as well as at least 31,350 pupils who benefitted from their teachers' implementation of Space Awareness resources and approaches within their classrooms. A further 8,283 pupils were also involved in completing the baseline pupil survey, which provides pioneering insights into European students' perceptions of space science. Section 2.2 goes on to consider specific patterns in these data, for example relating to participant demographics.

⁵ The figures provided here are a highly conservative indication of the overall project reach, as there were a number of other project activities delivered as part of Space Awareness that were not formally evaluated.

Space Awareness Activity	Number of Participants				
	Total	% Female	Primary : Secondary	Non-STEM	% Minorities ⁶
Pupil survey	9,202	51.5%	26% : 74%	n/a	unknown
Retrospective scientist survey	415	35%	n/a	15.7%	4.8%
Teacher training workshops	>481 educators ⁷	73%	27% : 59%	4.5% ⁸	unknown
	22,152 pupils	50.1%	16% : 84%	n/a	~10%
MOOCs	2,401 unique individuals ⁹	75.5%	20% : 55%	6.5% ⁸	unknown
Educational resources	212 educators	unknown	41% : 50%	13.5%	unknown
	9,198 pupils	51.3%	26% : 74%	n/a	~8.5%
Website	61,743	58.1%	unknown	unknown	unknown
Facebook	1,521	60%	unknown	unknown	unknown

Table 4 - Overview of participant backgrounds

⁶ Refer to section 2.2 for identified limitations in measuring diversity aspects such as the minority status of participants.

⁷ Only those captured by the evaluation processes are included here, though we are aware that some course participants did not complete the evaluations, and also that Type D training courses (run as part of an existing training session at the host organisation) were not required to participate in the Space Awareness teacher training evaluation. The true participation figures are therefore likely to be higher than the number given here.

⁸ Geography teachers are not included in these figures, though we recognise that throughout European curricula there are different perspectives on whether geography is considered a “science” subject. If geography is considered a non-STEM subject these figures rise to 13.0% for the teacher training workshops and 13.8% for the MOOCs.

⁹ This figure represents those who at least started a module and is therefore somewhat conservative regarding the numbers who engaged with the MOOCs overall: a much larger figure of 3,165 individuals registered for at least one Space Awareness MOOC, with 1,215 people completing a course.

2.2 Key participation patterns

From a **geographic** perspective, Space Awareness achieved a very wide area of influence. Evaluation respondents across all the activities listed in Table 4 represented at least 68 different countries, including every member state of the EU except Luxembourg. Participation patterns did vary according to activity, with the MOOCs and face-to-face training workshops being particularly successful in attracting participants from southern Europe (especially Italy and Portugal). Eastern Europeans were also in noticeably high numbers for the MOOCs (especially Romania) and the face-to-face workshops (especially Bulgaria). Although the United Kingdom attracted more than twice the target number of participants to the face-to-face teacher training workshops, there was in general a noticeable lack of participation from western European countries, representing only 9% of the MOOC cohort.

In terms of **gender**, only about one third of current space scientists in our retrospective survey were female, likely an accurate representation of what is a traditionally male-dominated field. Conversely, roughly similar numbers of boys and girls were involved in completing the pupil survey, testing the resources, and so on. This aligns well to the normal populations across most of Europe, suggesting that teachers included their whole classes (rather than deciding that space-related activities are better suited to only one gender). Given the strong involvement of female teachers within the various training activities (almost three-quarters for both the face-to-face workshops and the MOOCs), and the emphasis on supporting girls' development within that content, these figures suggest that Space Awareness has made positive steps in supporting female participation in space science. See also the orange shaded case studies scattered throughout section 4 for further examples on the impacts of the programme on girls.

Given previous evidence suggesting that young people's career aspirations are strongly shaped before the age of 12 years, particularly for science-related careers (see for example Tai et al. 2006, Archer & DeWitt 2017), Space Awareness included a deliberate focus on **supporting primary school teachers and pupils**. The evaluation evidence suggests this was successful, with at least one in five teachers coming from a primary school background for each of the major initiatives. It was also noticeable that the Space Awareness activities and resources tended to attract **highly experienced teachers**: for both the MOOCs and the teacher training workshops more than half the participants had taught for at least 15 years. We can speculate on why this might be (for example, more experienced teachers may have more confidence and self-direction, as well as better school support, to take up extra-curricula training, or better links with networks such as the Space Awareness partner nodes), however it does suggest that more could be done to support teachers who are newer to the profession. For example, working in partnership with professional teacher accreditation organisations may ensure Space Awareness tools and approaches are implemented by a wider range of professionals.

Another key focus for Space Awareness was broadening access to space science in schools by linking in with **non-STEM subjects**. Indeed, the retrospective scientist survey demonstrated that 15.7% of people considering themselves "space scientists" did NOT have a science-related initial degree, highlighting the relevance of other skills to the field. Within the Space Awareness activities there was evidence of some success on this front: 4.5% and

6.5% of participants in the face-to-face workshops and MOOCs were explicitly non-STEM, for example teaching languages, arts, history, religion and other humanities subjects. A further 8.5% and 7.3% respectively were geography teachers, another key target audience for the Space Awareness teaching resources.

A very strong motivating factor was **curriculum links**: 69% of teachers who tested the space awareness educational resources indicated that space science “is part of the curriculum so I have to teach it”. The initial curriculum review conducted as part of work package 2 was thus a likely important factor in the success of the Space Awareness resources, though there were calls from some respondents for those links to be more explicitly referenced within the supporting documentation.

Limitations in ascertaining diversity

A key intention of the evaluation work package was to specifically explore Space Awareness project impacts on diverse audiences. Where possible the participant numbers in Table 4 have been delineated by gender, school level, STEM (science, technology, engineering and mathematics links) and minority status. We did however encounter significant practical problems in comparing socio-economic status across Europe (and beyond). Previous surveys e.g. PISA2015 use around 17 separate proxy indicator questions to gauge pupils’ background, which was not feasible within our context. Additionally, feedback from both partners and nodes indicated that asking participants (teachers, pupils, parents etc.) overtly about socio-economic background, gender, religion and/or ethnicity is considered inappropriate and even illegal in some countries. Mentioning minority ethnic or religious groups was reported in some countries as being likely to raise suspicions and distrust and mean that participants would not complete the remainder of the evaluation activities (surveys, interviews etc.), or may create bias in the responses they provide.

In practice what this has meant is that within the evaluation toolkit materials the gender and religion/ethnic minority questions were kept as optional. So, for example, instead of insisting that teachers provide a breakdown of the gender and religious/ethnic minority backgrounds of the pupils they implemented a resource with, they could instead select the “prefer not to say” option. This means that many of the diversity figures quoted in Table 4 are very approximate, especially the “% minorities” but also “% Female”. Table 5 provides an overview of the proportions of respondents selecting the “Prefer not to say” option for the teacher training workshop and educational resources surveys.

It is noticeable that for both surveys, respondents were much more comfortable commenting on their pupils’ genders than they were on their minority status. These figures did also vary fairly substantially according to the respondents’ country of origin (Figure 1), reflecting the previous anecdotal feedback that there is a strong cultural association regarding whether asking such questions is likely to raise suspicion or create any other reporting problems.

Space Awareness Activity	% Females	% Males	% Minorities
Teacher training workshops [n=481]	10%	8%	26%
Educational resources [n=212]	18%	16%	41%

Table 5 - Proportion of respondents selecting "Prefer not to say" option within each survey under each of the indicated categories.¹⁰

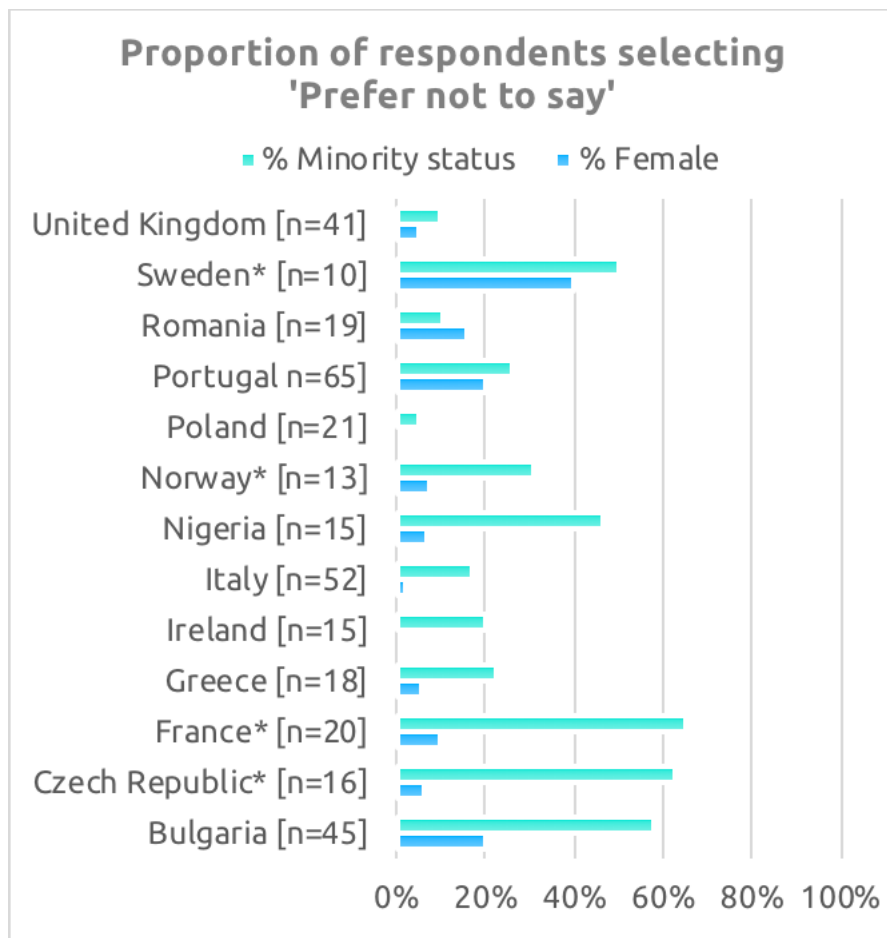


Figure 1 - Proportion of respondents selecting the 'prefer not to say' option in relation to their students' demographic characteristics.¹¹

¹⁰ Note that the 'Prefer not to say' option was provided separately for each category, rather than e.g. for gender overall.

¹¹ Note that the majority of these data are from the teacher training workshops, since those sample sizes were generally higher. However, those marked * are from countries which did not provide teacher training workshop feedback demographics, and are therefore taken from the corresponding Educational resources testing data.

Of course, there are many simple reasons, unrelated to ethical or cultural issues, why an individual may select 'Prefer not to say'. For example, they may not have the data to hand, or they don't know the answer, or it's easier than trying to enter a response when they're pushed for time. However, anecdotal feedback from various partners suggested that the underlying tensions around asking these questions were fairly serious, and certainly our data would support that belief (especially relating to minority status). Regardless of the reason, it is important that we recognise that such factors are very difficult to reliably ascertain, especially at international level.

To mitigate this problem WP7 developed an additional qualitative fieldwork strategy which explicitly focused on exploring such factors. Drawing on key Space Awareness events (the [Mission to Mars](#) teacher summer school; the [Space Scoop Comic Contest](#); the [Navigation through the Ages MOOC](#); and the [Celebrating Excellent Space Science Teaching](#) competition), the intention was to explore participants' perceptions, experiences and opinions through detailed qualitative analysis. Such analyses delved more deeply into available evidence than a simple questionnaire could achieve, and allowed a more sensitive and informal handling in order to get to the heart of the nuances involved. These qualitative insights have been incorporated into the overarching data synthesis described in sections 3 and 4 to provide further context and richness to the quantitative findings.

3 Quality assessment

The most fundamental indicator of success for the Space Awareness programme is the users' quality assessment of the resources produced. High quality materials and content are far more likely to be embedded within teachers' everyday practice, and/or used again for many years to come. This section briefly reviews the participants' perceptions of the overall quality, as well as specific quality indicators which can be used as a proxy for likely future uptake. Further aggregated figures are also included in the [Executive Summary](#).

3.1 Perceived overall quality

Within the major quantitative surveys we asked participants to rate the quality of the Space Awareness activity or resource that they had accessed. Figure 2 provides a summary of these ratings for the MOOCs, face-to-face teacher training workshops, and the educational resources.

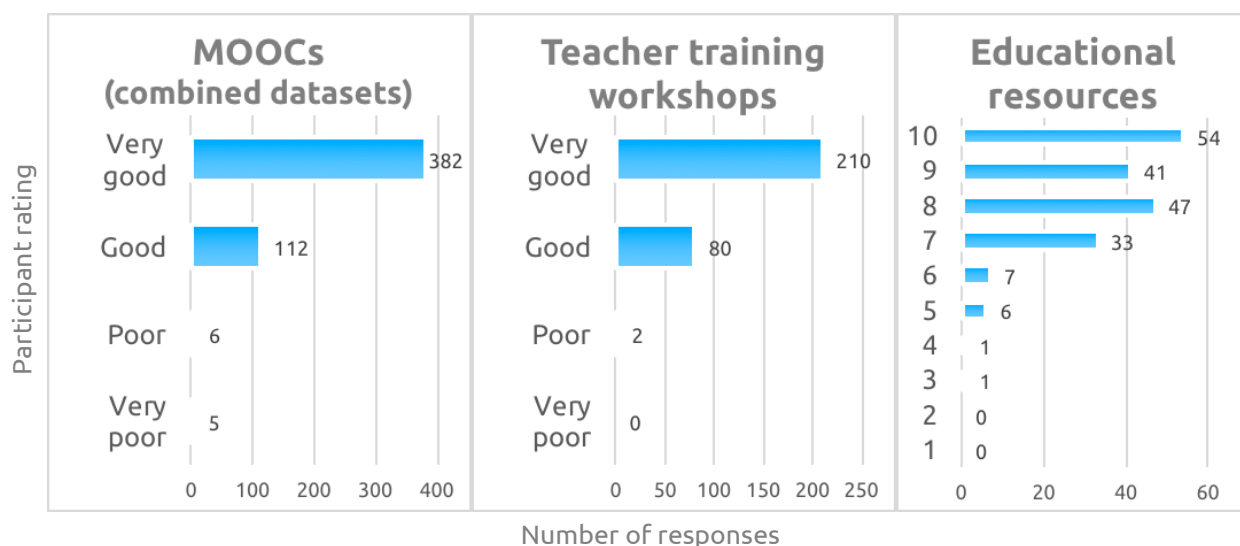


Figure 2 - Summary of overall participant ratings.

The ratings in Figure 2 are extremely positive: over 70% of respondents gave the top rating of “Very good” (or a score of 8, 9 or 10 for the Educational resources) in each case. This rises to 99.3% of combined “Good” or “Very good” for the teacher training workshops, and likewise 97.8% for the MOOCs. It is clear from these ratings that the resources and activities were overall received very positively, and were considered to be of high quality by those who accessed them.

Though not consistent across *all* of the different Space Awareness projects and activities, there were some key demographic trends in the ratings given. For example:

- Primary-level educational resources were statistically more likely to receive higher ratings than those designed for secondary school students ($p=0.012$).
- For the teacher training workshops, at least half of the respondents from every country selected the “Very good” rating, with eastern European countries in particular tending to score very highly (Romania, Bulgaria, Poland)
- Compared to their wider cohorts, geography teachers and females attending the face-to-face teacher training workshops provided particularly positive overall course ratings, suggesting that they found the courses well-suited to their needs.
- Conversely, there was evidence that further work is perhaps needed to tailor such content to pre-school (kindergarten) teachers.

Given the devolved nature of the project delivery, another useful indicator of quality is the course ratings provided by the workshop hosts, where none of the workshop organisers selecting “Poor” or “Very poor”. Indeed, 7 of the 11 respondents gave the highest rating of “Very good”, and the other four chose “Good”. Within their feedback many spontaneous comments were made regarding on the quality of the workshop resources, for example:

“The training guidelines were very good: very clear with easy access to the resources that were to be used.” (Workshop organiser)

“The training guideline was very useful and it helped us focus on the important points and aspirations of the project” (Workshop organiser)

Key success factors

In terms of “what worked well”, a wide variety of themes emerged, most notably relating to the “hands-on” and practical nature of the Space Awareness activities and resources and the high quality of the background materials (including any scientific content and images/visuals used). Space Awareness participants (especially teachers) felt that they had gained access to new resources or ideas for their practice, as well as specific knowledge.

Where relevant, respondents were also very complimentary about their interactions with other participants, frequently describing the MOOC atmospheres as ‘collaborative’ and containing a strong ‘community spirit’, and appreciating the relevance of the face-to-face training workshops to teachers outside traditional STEM subjects.

It was noticeable that respondents highly valued opportunities to inspire active involvement from their students, for example encouraging collaborative learning, discussion/reflection of key issues, physical involvement (especially primary activities involving movement), independent learning and creativity. Across the MOOCs, face-to-face training courses and reviews of the practical activities there was also mention of experiential elements, such as the opportunity to manipulate ‘real’ data, linking back to their existing knowledge, or simply having fun.

Limitations

The two most obvious identified barriers that were common across multiple Space Awareness activities and resources related to language and curriculum limitations. Although not a universal issue, in some countries the lack of availability of resources in the local language was a frustration to teachers and educators (and workshop organisers). Teachers also frequently asked for more explicit links between the activities and their own national curriculum, so that they could more easily justify the class time spent on the activity.

There were very few identified limitations that were common across multiple Space Awareness resources and activities, instead focusing on aspects that were specific to one activity or another. For example, face-to-face training courses that were 90-minutes or shorter tended to leave participants feeling that they hadn’t been able to fully engage with the content (especially the practical activities). Workshop participants also requested more activities for younger or lower ability students, whilst though generally positive overall, at least 10% of MOOC survey respondents reported encountering “significant” problems which prevented them from “making the most of the course”. These issues related to three key areas: (1) technical problems, (2) language issues, and (3) the timing/duration of the course (and/or particular tasks).

3.2 Individual quality indicators

Moving on to more specific evaluation ratings, respondents were also asked to provide ratings for pre-defined statements relating to the quality of the resources / activities. For brevity not all of the statements are included here, however two that are of particular interest regarding likely future uptake relate to whether the participant would recommend the resource/activity to a colleague, and/or be interested in participating in a similar activity

again themselves in the future. The responses to these two statements from the main quantitative evaluation of the Space Awareness resources are provided in Figure 3.

Again, the results are very strong. More than half the respondents in all cases selected the highest option (“Strongly agree”), which is a persuasive indicator that they felt that the quality and relevance of the resources was worth committing their own time, and/or that of their colleagues. The MOOCs in particular were very highly rated, with 97.4% of respondents at least “Agreeing” that they would recommend the course to a friend, and 99.2% that they would participate again themselves. Female MOOC participants were also statistically more likely than male participants to agree with the statement “I would like to participate in another similar course again” ($p=0.006$), suggesting that those courses achieved their aim of supporting women’s participation in space science.

We also explored whether there were any rating trends between the different course types (MOOCs / teacher training workshops) or across the separate educational resource activities. The patterns were broadly consistent, though the *Our Wonderful Universe* MOOC tended to score slightly higher, and the *Navigation Through the Ages* MOOC slightly lower, across most of the rating statements. There were no noticeable trends according to which of the various teacher training workshop options a participant attended, and the educational resources almost without exception tended to elicit a range of responses. There were no activities that were unanimously rated highly or lowly on any of the quality indicator statements, suggesting that the feedback was more based on individual teachers’ own situations and needs, rather than any of the activities being particularly strong or weak.

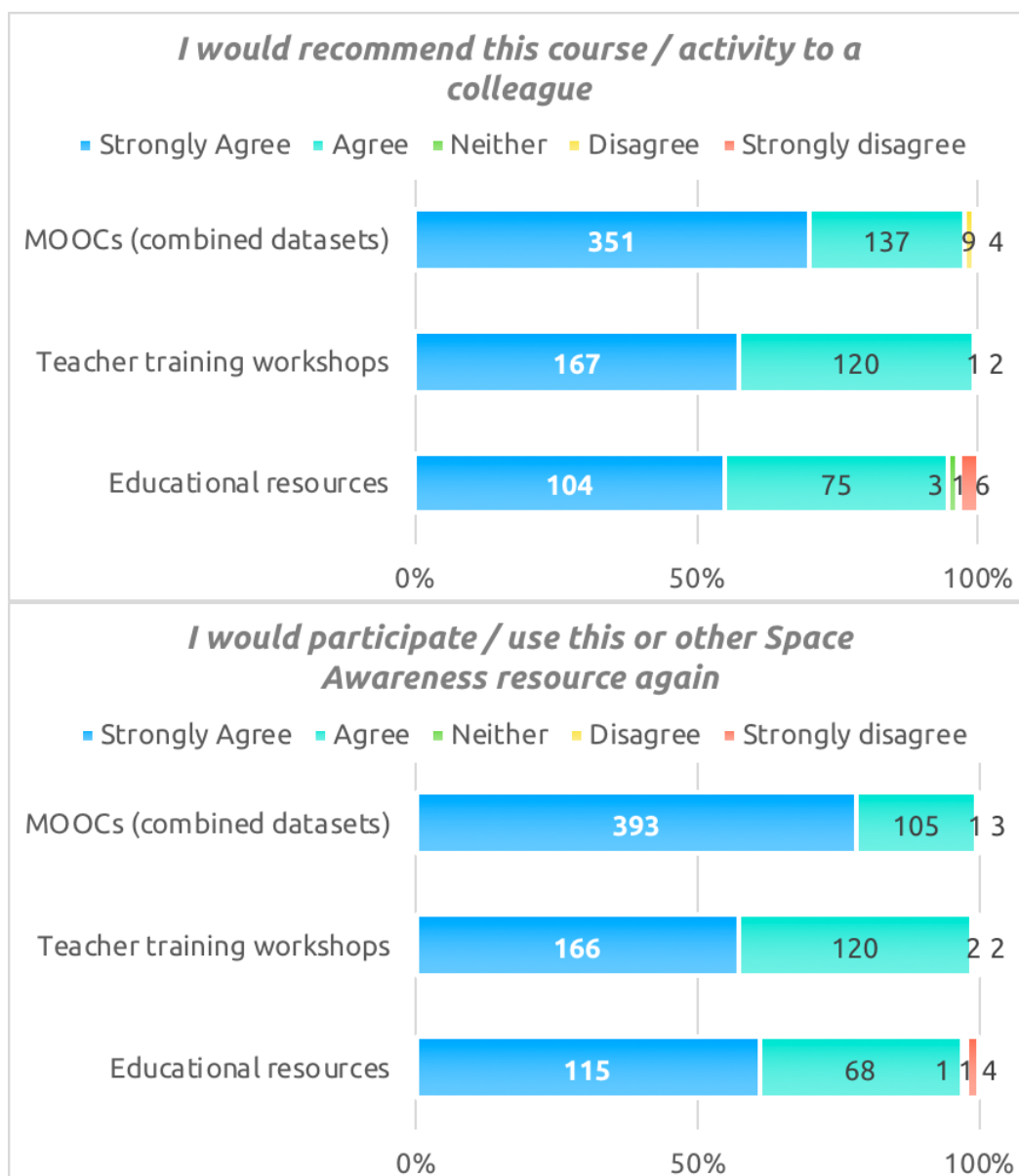


Figure 3 - Comparison of responses to key quality indicator statements across different Space Awareness activities.¹²

The remaining individual quality indicators showed very similar patterns to those presented in Figure 3, with very high “Agree” and “Strongly agree” ratings, and only very small numbers of dissenting ratings. In particular, at least three quarters of people who tested an educational activity agreed or strongly agreed that the majority of the teacher-related intended outcomes had been achieved for them, rising to over 90% for aspects relating to the helpfulness of the content and extent of information provision. Statistical analysis also suggested that the educational resources were particularly effective in supporting primary teachers. This is excellent news for the Space Awareness project, as primary teachers were a key intended audience (see section 1.1.1).

¹² Note that the neutral response ‘Neither agree nor disagree’ was only used for the Educational resources survey.

The most notable exception was for the statement “The course discussions were useful for my learning” for the MOOCs, where 6.1% of respondents disagreed or strongly disagreed. This is still a relatively positive rating, but suggests that the course discussions were perceived to be weaker than other elements of the course. Additionally, 5.8% of respondents disagreed/strongly disagreed that “The activity was at the right level for my students” in relation to the educational resources – where possible such feedback was incorporated into the instructions and support materials associated with those resources.

4 Overarching outcomes

We move now to the main evaluative focus for Space Awareness: determining what changes occurred for the participants as a result of their involvement in the programme. After an initial overview this section is divided into five components, each considering a different type of outcome as delineated previously in Table 3: *Feel, Value, Understand, Do, Skills*.

Referring back to the [Executive Summary](#) at the start of this report, Table 1 and Table 2 provide a visual summary of the extent to which our evidence supports whether the various intended outcomes outlined in Table 3 were actually achieved within the Space Awareness programme. The final columns serve as “traffic light” indicators of the extent to which each outcome appears to have been achieved¹³.

Overall these results are extremely positive. There is evidence that the majority of the intended outcomes were achieved within the Space Awareness programme. We can be confident that Space Awareness has contributed to changes in the everyday practice of teachers across Europe and beyond, and that this is having ongoing impact on learners’ individual awareness of space science which will be beneficial far beyond the life of the project.

¹³ In addition to participants’ self-reported responses to direct statements on these aspects, these judgements have been based on a synthesis of participant feedback and wider qualitative evidence collected across the Space Awareness programme. Note that the key to the colour scale used is included at the bottom of each table.

A note on data presentation within this section

In addition to the indicative quantitative data, and other synthesised findings included in the main text, a series of case study Examples have been scattered throughout this section. These Examples are designed to provide a glimpse into the richness of participants' experiences within the Space Awareness programme. They have been annotated according to the type of priority target audience they involve (see section 1.1.1 for details). Where appropriate, some case studies display multiple annotations to represent the involvement of more than one priority target audience.

It should however be noted that as outlined in section 1.2, this report represents a synthesis of the main findings from many different areas of effort within the Space Awareness evaluation work package. For the purpose of brevity and coherency, only specific highlights within the data evidence are presented here. Due to the manner in which much of the data was gathered, we cannot claim that all the responses shown here are representative of the entire cohort of Space Awareness participants. Nor do we necessarily claim that the case study Examples distributed throughout this section are 'typical' responses. They have been selected as illustrations of the sorts of impacts achieved within the Space Awareness programme from a holistic perspective. Further information regarding each of the datasets and analysis is contained within the various separate reports highlighted (with links provided) in section 1.2.

4.1 Feel: Enjoyment, inspiration & creativity

The *Feel* category (involving stimulating positive emotional reactions to space science) was a major priority outcome category for the Space Awareness project, and it is very clear from the evaluative evidence gathered that there were strong successes in this area. For example, Figure 4 summarises the participant ratings relating to 'inspiration' from the three major evaluation surveys: those relating to the MOOCs, teacher training and educational resources. Example 1 also provides a flavour of the type of qualitative responses received, in this case regarding the *Teaching with space and astronomy in the classroom* MOOC, whilst Example 2 demonstrates a primary school teacher gaining more confidence in teaching space content through the provision of in-depth background information within the Educational resource they tested.

"I enjoyed that I got to participate, share, get inspired, learn so much, communicate so greatly interesting things, try new practices in class, challenge my view and learn from teachers and scientists. I enjoyed how the course released the different topics in a balanced, clear and friendly way. I loved how the people presenting the topics loved what they were talking about."

(Greek primary school teacher)

Example 1 - Emotive response to participation in a Space Awareness MOOC

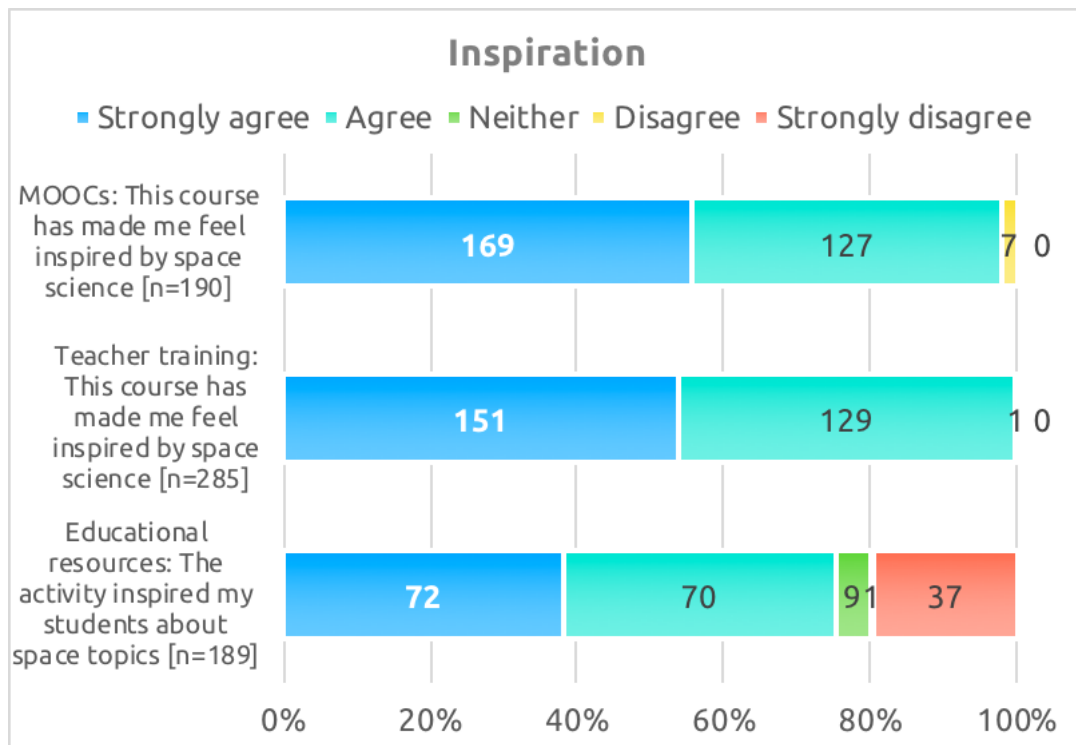


Figure 4 - Comparison of participant ratings relating to 'inspiration' for each of the major Space Awareness evaluation surveys.¹⁴

The proportion at least agreeing with these statements is over 75% in each case, rising to 96% for the MOOCs, and 98% for the face-to-face teacher training courses¹⁵. Indeed, for both types of training over half the respondents selected the maximum rating of “Strongly agree” in response to the statement “This course has made me feel inspired by space science”, a very convincing endorsement. Similar results were achieved for statements relating to both teachers’ and pupils’ levels of enjoyment, as well as feeling more “positive” and “interested”, and for teachers reporting increases in their own confidence in teaching space topics.

“[The educational resource I tested was] a very engaging and fun activity to complete with children. Excellent background information to enable teachers to feel confident teaching the theory. [...] By providing such thorough background resources, as a teacher I felt more confident teaching the children about the subject. I was able to decide which information was relevant for them and use this to aid their learning and outcomes.”
(UK primary school teacher)

Example 2 - Increased confidence in teaching space topics

¹⁴ Note that the ‘neither’ option was only used for the Educational resources survey.

¹⁵ It is true that 19.6% of people who tested the educational resources selected “Strongly disagree” for this statement, though in the associated comments many of them explained that this was because their students were “already” inspired by space, and therefore they couldn’t attribute such inspiration purely to the activity they trialled.

The only statement within this category for which the evidence was less conclusive related to whether students “Aspire to space science careers” as a result of their participation in Space Awareness activities. There is no doubt this was achieved for certain individuals, especially within the *Teaching Excellent Space Science* competition (see Example 3 below, as well as various anecdotal evidence from our other qualitative analyses). However, the evidence was not consistent across the cohorts. In part this was due to methodological limitations: due to ethical reasons and lack of resource the partner nodes could not be expected to follow up directly with students, so we instead relied on data reported by their teachers. In addition, measuring changes in aspirations requires a more in-depth, longitudinal approach (e.g. Archer & DeWitt, 2017), which was not possible in the scope of this evaluation. Our efforts within Space Awareness in developing the Europe-wide [pupil baseline survey](#), combined with our database of teachers willing to be contacted for follow-up research at a later date should allow such issues to be further investigated from a longitudinal perspective in the future.



One educator in India chose to work with a group of children aged 10-16 years old from slums in the Trichy Region. Most of their parents are on daily wages and work in construction and gardens. They have seen the sky at night but have no knowledge of space science. There was no classroom and no timetable. But the educator described the children as being curious and inquisitive. After their discussion one student wanted to know more. She is now studying in middle school and asked questions about a career in science. She invited the educator to visit her parents to explain to them the opportunities that are possible. *“That was an amazing outcome of my session in the slum. This has inspired and motivated me to teach space science to more groups of children.”*

(Indian Educator)

Girls

Disadvantaged students

Example 3 - Improving Indian slum inhabitants' aspirations towards careers in science

4.2 Value: Attitudes & values

Moving on to the second outcome category shown in Table 1, *Value*, this was also a major intended priority area for Space Awareness. The quantitative results here are less conclusive than for the *Feel* category outlined in section 4.1, though in the main this was due to methodological limitations meaning that some of these aspects were not explicitly explored within the data collection tools we implemented (this explains most of the grey-coloured boxes in Table 1 and Table 2). The MOOCs were particularly strong within this category; as shown in Figure 5, over 57% of respondents chose the top option of “Strongly agree” in relation to the three *Values* statements indicated, and over 95% at least agreed in each case. Open-response comments from MOOC participants suggested the course content (which contained aspects which explicitly focused on these areas), as well as the international and highly collaborative nature of the MOOC learning environments greatly helped achieve these ratings.

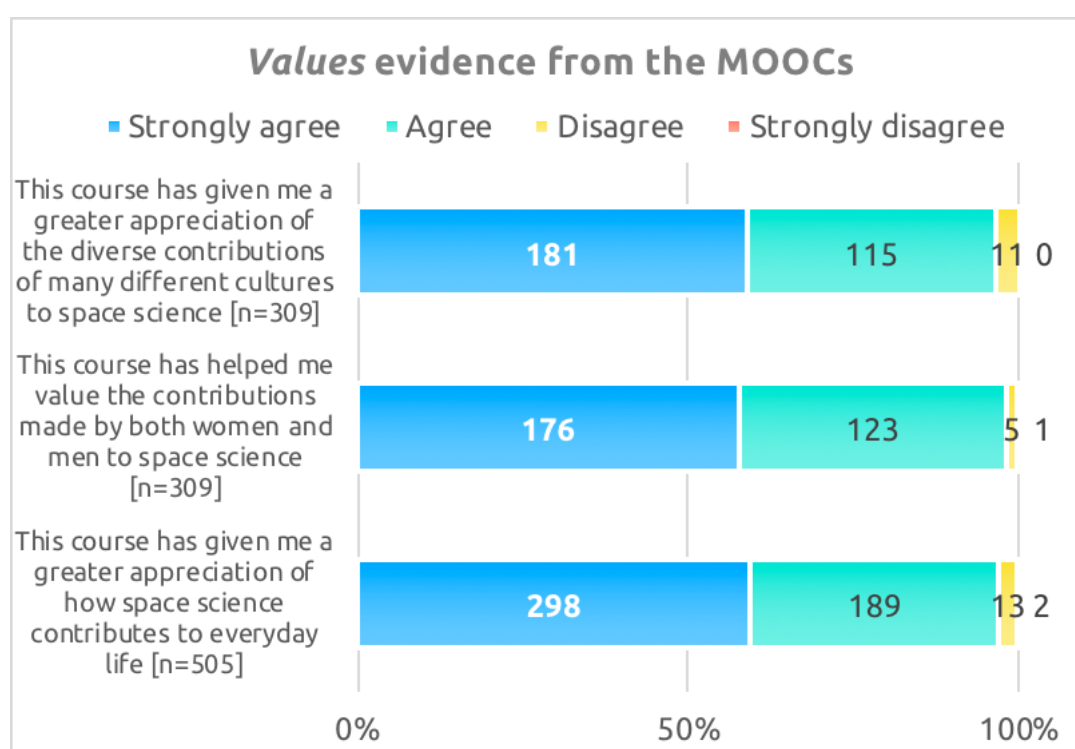


Figure 5 - Participant ratings to key Values statements in the MOOC evaluations

The other *Value* outcomes were not explicitly explored within the questionnaire surveys; the ratings in Table 1 and Table 2 are instead based on aggregated qualitative evidence. As such there are many excellent examples of specific places where there was evidence of the intended *Values* being achieved: indeed, Example 5 incorporates almost all of them. The other Examples in this section showcase other complementary *Values*: European and Global Citizenship (Example 4), links to everyday life (Example 6), increased appreciation of the relevance of school science (Example 7) and the diversity and accessibility of space science careers (Example 8).



The images in this Example are from the Iranian national contest winning entry in the *Space Scoop Comic Contest* (with associated English translation). They were drawn by Mani, a 9-year-old student, based on the Space Scoop news article [British Astronaut Blasts Off to International Space Station](#). Participants in this story are benign celestial objects with smiling faces. They gaze at the astronaut hero like approving elders. The vectors follow the gaze of these celestial bodies to frames 4 and 5 where extended hands are shaken and waved in affirming friendship. The green alien looks directly at the audience while the human astronaut's face is hidden by a helmet. The relationship is consolidated with a gift and the language throughout invokes very positive associations ("dear alien", "I'm so happy", "It's really enjoyable", "so magnificent"). The last frame is modestly proud as the hero is applauded by a cheering crowd representing a wide diversity of backgrounds. In this celebratory story of discovery, inspiration and hero worship the astronaut figure is evident throughout. The young artist has embraced and celebrated the possibility that an astronaut from Iran could be chosen by NASA to go into space. As noted by the judges, "*His comic tells a charming story, which carries a poignant message about bringing peace to the world. The comic is neat and concise, and the hand-drawn style of the artwork is unique and vibrant.*"

Minority backgrounds

Example 4 - Case study of an Iranian student valuing trans-national European and Global citizenship in relation to space science

SCIENTIX
The community for science education in Europe

WOMEN IN MATH AND IN SCIENCE
Gabriella Ricci
Junior High School "A. Belvedere" Napoli IT

What could we do to win the stereotypes about the women that work in these fields?
What do you think about women in math and science?

Italians students reflect on these issues with the Croatian students during the International Women day (the result of this work is on the padlet) <https://padlet.com/gabriellaricci/1blupag15ow>

Report of conference (8-03-2017):
The main theme was the occupation of the women in scientific fields.
At the end of discussion our student arrived to the conclusion that, to spread the idea of women as worker in scientific fields, **we should to teach it to students from primary school.**

The work presented on this poster has received funding from the European Union's Horizon 2020 research and innovation programme – project SciEntix 3 (Grant agreement N. 730009), coordinated by European Schoolnet (EUN). The content...

Two teachers from Italy and Croatia developed a joint project focusing on bridging the gender gap and encouraging gender equality, a topic they were both passionate about. The challenge was turning this into a collaboration across borders in schools that were in different nations. The teachers assembled resources from across the Space Awareness project: careers profiles; discussion prompts; role descriptions; webinars; and teaching materials. During a joint Skype conversation between their 14-15 year old students they came up with a timetable and plan of how to proceed with the project. In smaller groups, the students wrote down their thoughts, ideas and impressions on STEM and the gender gap. The teachers provided the pupils with a list of women, past and present, who have contributed to science. They asked the pupils to investigate the careers and lives of these women and try and find more individuals who made a change in the world. Each group presented their work to their peers and then all the material was combined. This resulted in posters, PPT presentations, kahoot quiz and a padlet share space. A follow-up Skype lesson between the schools provided an opportunity to present their final work to each other. They also reported their experience on their school web page and presented the project to other staff at both schools.

The boys in our classes concluded that: *"Women inspire all of us not just girls. Why should we emphasise their contributions as 'The contributions of women' ? It is their contribution as people of the human race that inspires us."*

The girls in our classes concluded that: *"STEM careers are the future and they are all part of the future. Whether they are girls, boys or from different ethnic backgrounds, the importance is the passion they have for science. This should be nurtured from an early age."*

"The Space awareness website proved to be a valuable resource. Many topics and webinars were available to the children to read and listen to, in class and then in their homes. In smaller groups the children soon discovered that women had to overcome stereotypes in the past to prove themselves. These women are inspirational to all children, boys and girls."

(Croatian secondary school teacher)

Girls

Example 5 - Case study of students collaborating internationally to explore contributions made by both men and women to space science

"[The educational resource I tested contained] clear instructions for the teacher [which] helped me feel more confident in completing the activity. The activity was taken out of the lab and completed outdoors. Life beyond the lab and demonstrates that science is not just confined to the lab."

(Irish secondary school teacher)

"After trying to find engaging ways to teach night and day and failing, it was helpful to find a resource [through Space Awareness] that made the teaching fun and 'real' for the children to grasp. Especially for those who are less able who find concepts hard when not seen in a real context."

(UK primary school teacher)

Example 6 - Increased appreciation of links to everyday life

Example 7 - Increased appreciation of the relevance of school science

Astrophysicist

MY SKILLS & INTERESTS

- Enjoy math and science.
- Have a good imagination.
- Work well on your own.
- Enjoy working with computers.
- Enjoy solving mysteries or problems.
- Enjoy learning about new things
- Do well in math and science, physics, chemistry, astronomy and electronics.

WHAT I DO

I study celestial objects like galaxies, stars, and planets in order to understand what they are made of, what their surface features are and how they were formed. Astrophysicists spend most of their time in observatories, laboratories using instruments like telescopes, satellites, sensors and probes. They also spend time in their offices analyzing the information gathered by these instruments. Theoretical astrophysicists also spend time forming theories about how objects in space are formed or structured. Astrophysicist's involved in observational astrophysics mostly spend time making observations with instruments. This may require travel to faraway locations. Astrophysicists work a lot with computer simulations and computer programming.

STORIES THAT INSPIRE

INFORMATION

Information source: NASA

Russian astronaut with Greek origin

Astronaut talks with students!



A secondary school teacher in rural Crete reported dramatic success in using the Space Awareness resources to raise the career aspirations of her 15-year old students. Most of her class were from low-income families in an isolated community employed in seasonal agricultural activities, with few of the female students having any specific career goals. The students watched the Space Awareness career videos as part of a classroom discussion and became very animated. As well as being impressed by how young the people presented in the video were, they had never heard of some of the space professions, "it was inconceivable for them that a lawyer can work on space issues! [...] They were also impressed by watching several women following a space-related career."

"I was very interested that using the Space Awareness material changed the established and perhaps anachronistic positions of the students, e.g. that space is only for men, or only for genius people who live in the U.S.A."

(Greek secondary school teacher)

Girls

Disadvantaged students

Example 8 - Disadvantaged students discovering the diversity and accessibility of space science career opportunities (especially girls)

4.3 Understand: Knowledge & understanding

Conceptual development was a strong motivating factor for the majority of participating teachers, both for themselves as well as the pupils they teach. From a factual perspective there was clear evidence of participants developing knowledge relating to the three key Space Awareness themes: *Our Wonderful Universe*, *Our Fragile Planet*, and *Navigation Through the Ages*¹⁶. Though the other activities also demonstrated strong knowledge development, the most detailed evidence we compiled on this front related to the MOOCs, where we were able to directly compare participants' pre- and post- course knowledge on specific topics. These results conclusively showed that although respondents' self-reported knowledge was in general relatively high to begin with (there were very few selections of 'none' in the pre-surveys), they became much higher post-course for every area of knowledge covered. See Figure 6, for example, which shows results from the *Navigation Through the Ages* MOOC.

The most noticeable shifts occurred in more specialist topics, for example different ESA missions, exoplanets and celestial objects. In these cases, the proportion of people who felt they understood 'A lot' or 'some' of each concept increased from around 30-40% to 70-90%. Our Fragile Planet was also reportedly very effective in communicating about space careers: prior to the course less than 50% of respondents felt they knew more than 'A little' about different space career opportunities, but this rose to 98% post-course.

Additionally, there was clear evidence of the MOOCs having specifically supported *females'* confidence in space science. For every one of the 17 knowledge-related questions asked prior to the course, males on average reported a higher level of confidence in their understanding than their female counterparts (6 of which were statistically significant). Notably, none of these statistical differences remained after the courses, and females (on average) expressed greater confidence than males for 7 of the 17 questions in the post-course surveys. This suggests that the Space Awareness MOOCs were particularly successful in building up female participants' confidence and supporting their knowledge development.

¹⁶ Resources associated with the fourth theme, *The Journey of Ideas*, were not released publicly until towards the end of the project, so could not be included in most of the evaluation data collection.

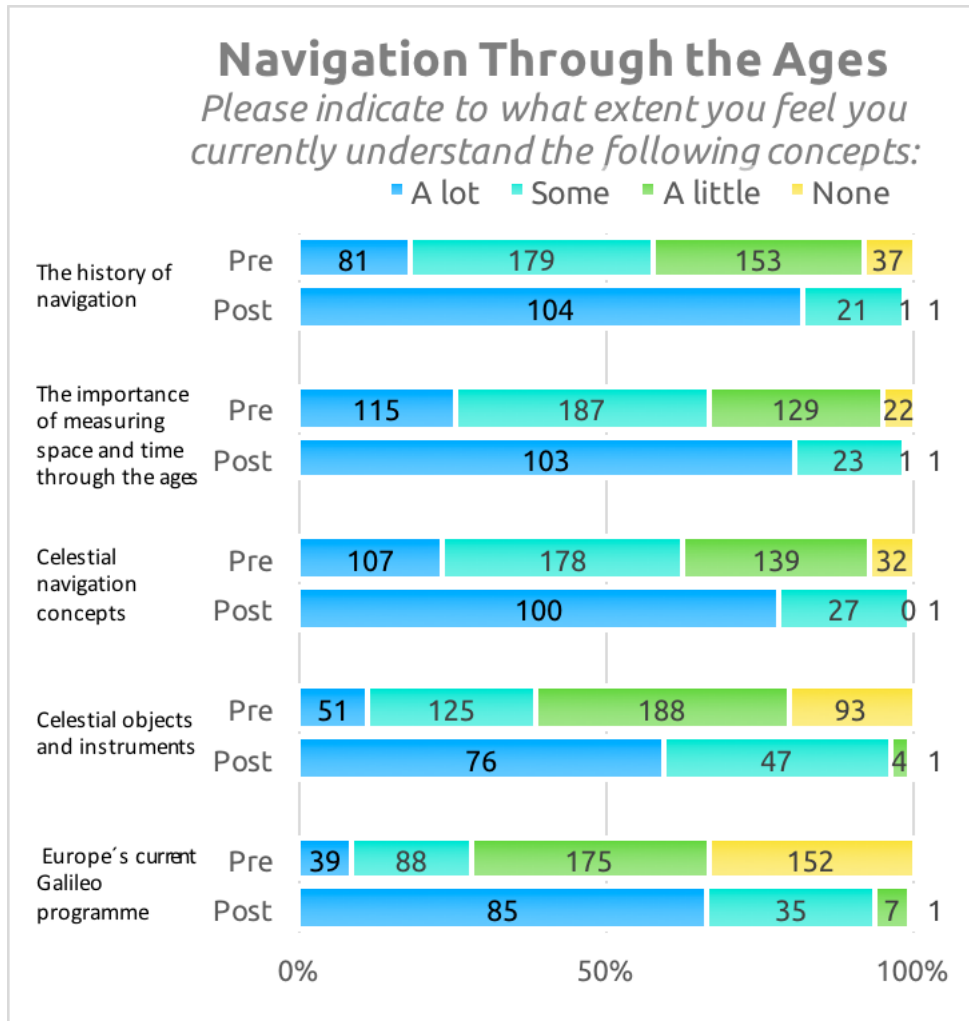


Figure 6 - Self-reported understanding of key Navigation Through the Ages MOOC content, compared before and after the course

The interdisciplinary opportunities afforded by space science were very much welcomed by the teachers who participated in Space Awareness. For example, teachers who attended the face-to-face workshops reported gaining a better appreciation of and even inspiration from seeing space science as relevant across many disciplines (Example 9). Furthermore, comments regarding the involvement of teachers from broader backgrounds (outside traditional STEM subjects) were highly favourable from both participating teachers and workshop organisers alike. This suggests that the aim of embedding space science into broader areas of the curriculum beyond physics and mathematics was (at least in part) achieved. Indeed, multiple workshop organisers expressed overt enthusiasm and even surprise at how

"[One of the things I enjoyed most about attending this course was] noting that it's not just science related. History colleagues and others can benefit from my attendance if I discuss my participation on today's course with them."
 (Irish school teacher who attended a face-to-face training course)

Example 9 - Increased appreciation of the cross-disciplinary relevance of space science

multiple workshop organisers expressed overt enthusiasm and even surprise at how

appreciation of space science as a global endeavor. However, as with the ‘aspirations’ mentioned within the *Feel* category in section 4.1, further longitudinal work directly with school students is required to fully explore their perceptions of space science careers.

Returning to the rural Crete students mentioned in Example 8, it was clear that there was a specific influence on students’ (particularly girls’) awareness of the diversity of space-related careers, and their own aspirations towards such careers. Before their interaction with the Space Awareness resources the teacher first facilitated a discussion about career options and how they could go about making informed choices. The teacher posed some open questions, for example “Can you imagine yourself working on something related to space?” Most of the young people felt this would be impossible: *“some of the students were suspicious [...]. They believed that the space-related professions had nothing to do with the Greek reality and especially with the reality of their small, isolated village. They also believed that women do not have any access to these professions.”* Their engagement with the Space Awareness interviews and role model examples described in Example 8 had a strong effect on their perceptions however. *“Students were thrilled by the (unexpected) vast variety of space-related professions as well as by the (also unexpected) equal opportunities that men and women have in this field. [...] Through the interviews and the material of Space Awareness they have completely reviewed their initial opinions.”*

Some girls started to change their attitudes towards science-related disciplines. The boys said that their horizons had been widened. They never imagined that some professions (e.g. artists) could be relevant to space science. One of the girls had previously been interested in psychology, and by playing the Space Awareness card game she learnt that a psychologist worked for Space Agencies - she could not believe it. After discussing it, everyone realised that it is very normal that psychologists are necessary in such stressful situations as space missions. The boys were also impressed by the fact that many women pick out professions of scientists.

The students directly asked if they themselves could follow these careers and what qualifications they would need and where they could study, with a particular focus on Greece and Europe.

“In the classroom there was a beautiful and constructive upheaval, as in few hours several strong stereotypes had been collapsed. Most students shouted to see more things about space. Some of them wanted to see more details about aircraft engineers. Generally, there was a turn of the students’ opinion about space-careers and they showed great interest not only on the space-related professions but also for the planets, the rockets and in general for most of the topics that are covered by space science. The material provided by Space Awareness offered an excellent chance to present to the students of my school unknown but inspiring space-related careers from which students gained a lot of creative ideas.”

(Greek secondary school teacher)

Girls

Disadvantaged students

Example 10 - Disadvantaged students discovering the diversity and accessibility of space science career opportunities (especially girls)

4.4 Do: Actions, behaviour & progression

In general, determining what participants *Do* (their progression or changes to their behaviour) as a result of an intervention is very difficult to ascertain. This is because of the need to follow up with participants, which is rarely straightforward, and because what people do is often influenced by a range of factors beyond the intervention. It is remarkable then that this was a key area where Space Awareness was able to demonstrate clear

evidence of achieving all of the intended participant outcomes. There is no doubt that participants were able to access and use the Space Awareness activities confidently, including adapting and extending the resources provided for more specific use within their own classrooms. For example, the 1,215 teachers who completed the final task within the MOOCs (publishing a teaching plan) all accessed and applied materials and activities from the MOOCs confidently, creating teaching plan lessons across multiple disciplines including Geography, Science, History and English. Across all the activities teachers used highly active phrasing to describe their students' eagerness to learn more about space science, for example being "mad" for space science, or "desperate to know more" (Example 11). There was also evidence of individual teachers inspiring their classes to consider space science careers (such as Example 10).

"One student who had more or less been asleep all year came alive when she heard of the big bang theory - and was really mad that my answer was 'I don't know, they don't know!' Mad enough to go home and read more, and have more questions the following day. This student isn't experiencing much academic success in other areas of school, but in Science participates and is developing some good physics skills. Regardless of whether she pursues any career in Science, the inspiration has kept her engaged and been really great for her self-esteem in particular with regards to Science."
(Irish secondary school teacher)

Example 11 - Inspiring difficult students to want to learn more about space science

Teachers who participated in one of the Space Awareness training opportunities (whether online via a MOOC or face-to-face hosted by a national delivery partner or node) were explicitly asked about their intentions regarding encouraging their pupils to pursue careers in space science and related subjects (Figure 8). By the end of the 6-week MOOC, 40% of participants "Strongly agreed" that they had *already* "encouraged my students to pursue careers in space science, including girls and/or students from diverse backgrounds". This rose to 89% who at least agreed with this statement. In the face-to-face training the question was phrased slightly differently (the questionnaire was distributed before the participants had a chance to implement their new knowledge), but the proportion who selected the highest rating remained the same. Over a quarter of respondents (28%) did however indicate that introducing space careers to their students was "not applicable". These were mainly primary school teachers who did not immediately see the relevance of careers advice to the age of students they taught.

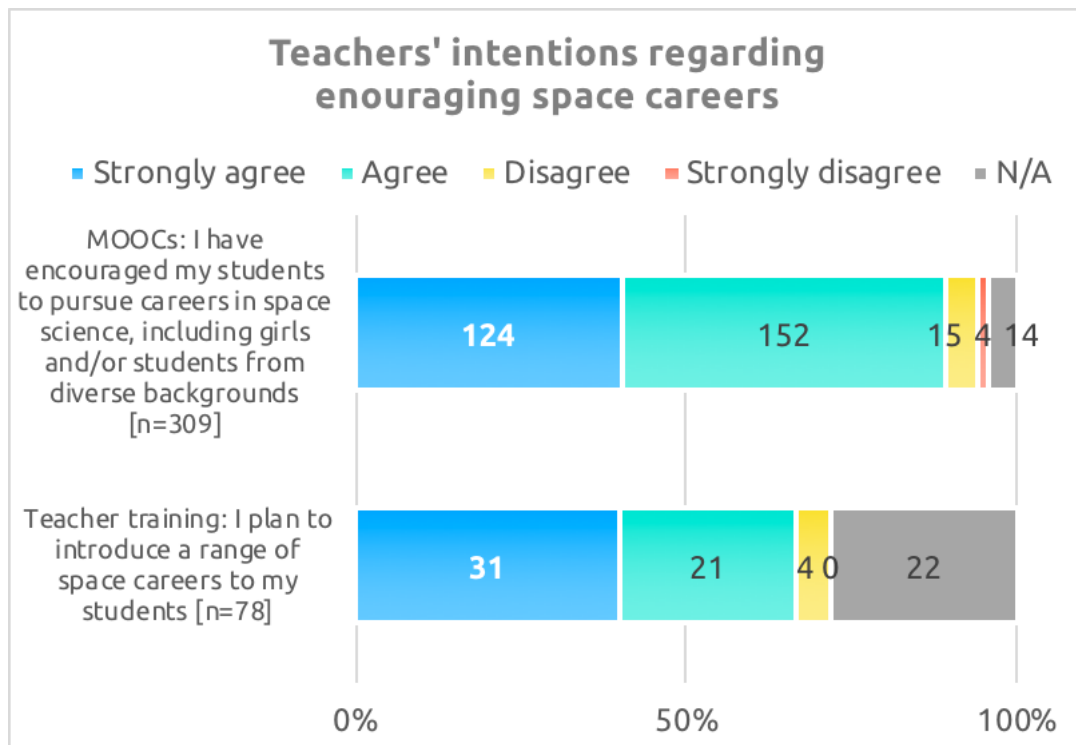


Figure 8 - Comparison of participant ratings relating to encouraging space science careers

The most overt *Do* outcome within Space Awareness related to participants sharing their newly developed understandings with others. Participants from across all the activities were enthusiastic and active in telling others about their experience – whether it be their colleagues, friends, family or wider community (Example 12 & Example 13). Teachers evidenced numerous presentations, performances, posters and displays through which the pupils shared their knowledge. The teachers themselves were also highly active, especially on social media but also traditional media such as TV. Female MOOC participants were especially emphatic in this regard, being statistically more likely to agree that “I have shared what I have learnt with my colleagues” than their male counterparts ($p=0.025$).

An educator in the Netherlands used one of the Space Awareness educational resources to explore representations of the sun-Earth-moon model with young people visiting a science centre. He described the most enjoyable part of the activity as being “*the conversation in which we talked about what they already knew (including their misconceptions).*” By using small spheres the educator also invited the children to try to describe how they thought the model worked. This discussion was then extended into a craft activity where the children took home their own mobile version of the model. Both the craft aspect and being given a tangible product from the workshop appeared to greatly help the children’s enthusiasm for sharing their learning with their wider family. The educator noted that “*Some of the kids (mostly the girls) also liked making the mobile and the idea that with the help of the mobile they could now explain it themselves to their (grand)parents, neighbours et cetera*”.

(Dutch Science centre educator)

Girls

Example 12 - Inspiring girls to communicate with their wider family about their space science activities through craft



11-year old children from a bilingual Muslim school in Greece worked in groups as part of their Greek language lessons to create puppet show on the theme of Astronomy. The content was chosen by the students, based on information contained within the Space Scoop resources. Once the students were familiar with their topic they had complete freedom to decide the direction of their work. They decided to create a collaborative scenario of dialogue-interviews, and a shadow theatre play introduced by a dance sequence. Students used resources on storytelling to get ideas, Space Words to look up technical words, and browsed ESA and NASA websites for visual material. They created all their own props and art work and their final performance was presented to the whole school, and shared more widely beyond the school. Accompanied by an interview with the teacher, the children's work was presented on the TV show "Space News" on a children's TV channel and then as a [YouTube video](#) within the *Our Wonderful Universe* MOOC.

Minority backgrounds

Example 13 - A widely-shared astronomy-themed puppet show developed by Muslim students' as part of their Greek language lessons

4.5 Skills

The final intended outcome category, *Skills*, showed mixed levels of achievement across the Space Awareness programme. By far the strongest element was the development of inquiry-based skills, both directly by the teachers involved in the various activities, as well as their students. Indeed, inquiry skills were highly valued by the teachers: in the testing of the educational resources, activities judged to be poor in developing the students' inquiry skills were statistically more likely to be given a lower overall rating by the teachers ($p=0.044$). Conversely, resources that were specifically linked to ICT were statistically more likely to be used again in the future ($p=0.048$) or recommended to colleagues ($p=0.032$), suggesting that skills in inquiry and ICT were valued by the participating teachers, and that effective ICT tools are sought after by European teachers, and act as an additional hook during decisions relating to ongoing use of particular resources. This was particularly true for multimedia and video resources produced within the Space Awareness programme. However, across the Educational resources, careers aspirations and ICT skills were judged by the participating teachers to be less well supported by the resources than aspects relating to knowledge or emotional reactions (sections 4.1 to 4.3). This is not to say that the ratings were poor in this regard, just less positive than some of the other intended outcomes.

Within the MOOCs we explicitly investigated the extent to which the various intended skills were embedded within the participants' longer-term practice. This was achieved by comparing individuals' responses to key prompt questions at three stages: before the MOOC began, immediately after its completion, and approximately two months afterwards (Figure 9). Though the numbers involved are relatively small¹⁸, the patterns across all three statements are remarkably similar: for these individuals, their reported agreement increased noticeably between the pre- and post- surveys. Perceptions then tended to drop back a little in the delayed survey¹⁹ (when the course content would have been less apparent in the participants' minds), but remained higher than the original pre-course ratings. Almost identical patterns were observed in the pre- and post- course survey comparisons for the face-to-face teacher training sessions. It is clear that participants felt the courses successfully impacted upon their practice in terms of managing diversity in their classroom, and using inquiry and ICT to teach about space science (see also Example 15, Example 14, and Example 16 here).

¹⁸ This was because this technique relied upon the survey respondents being willing to provide an anonymous identifier code in all three surveys in order that we could connect their data together. Additionally, due to reasons of timing, the 3-stage evaluation process was only implemented for 2 of the 4 MOOCs.

¹⁹ Another reason for the slight drop-off in ratings in the delayed survey may have been due to the phrasing of the survey statements, which (compared to the pre- and immediate post-course statements) were more focused on active behavioural changes (delineating what they HAD done rather than only intended to do or hypothetically felt comfortable about).

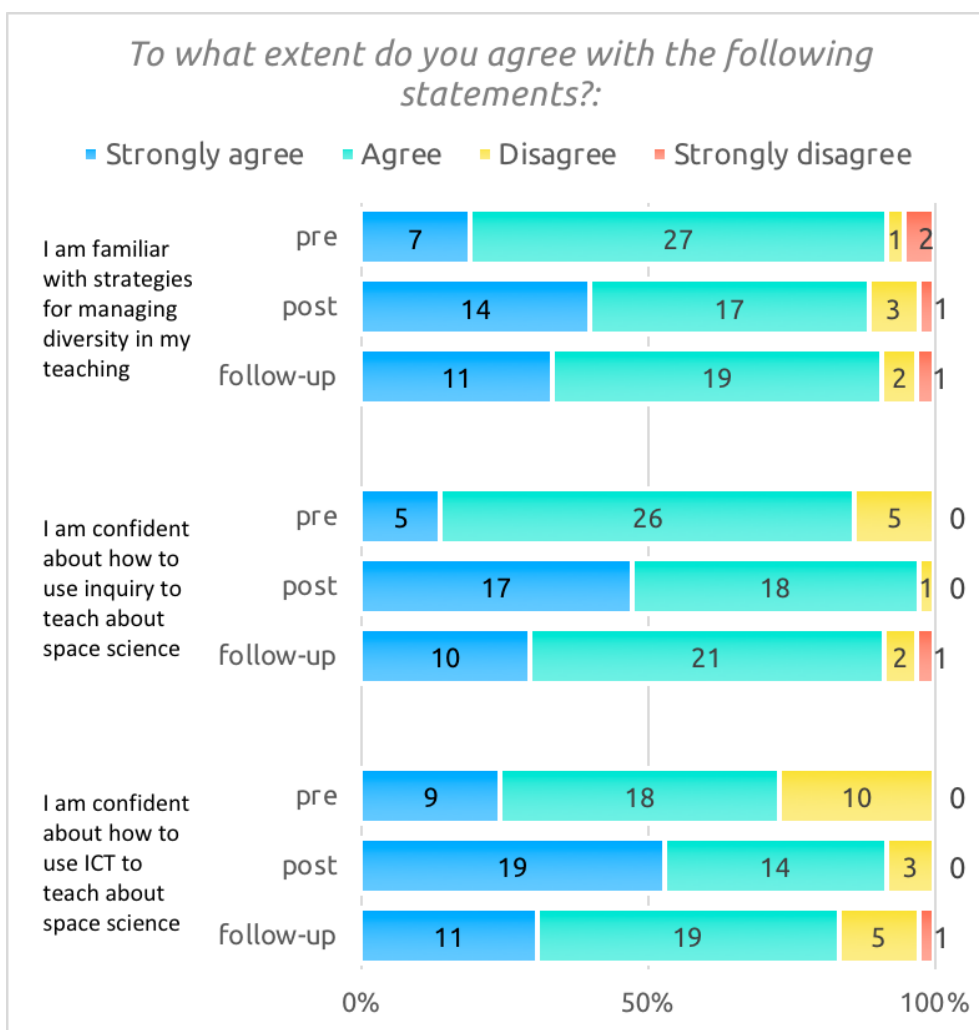


Figure 9 - Comparison of individuals' responses to key indicator statements at different stages of the MOOCs [n=37].²⁰

As part of their trial of one of the Space Awareness educational resources, a UK primary school teacher noted that *"the practical element of the lesson worked well. The key questions identified allows for a variety of thinking levels and strategies. I like how the conclusion of the lesson requires the children to link their investigation findings to another question. This brings the topic to life and allows them to learn in an inquiry based style that is practical and hands on rather than just carrying out more stale research."*

(UK primary school teacher)

Example 15 - Developing pupils' inquiry skills

"[The best part of this activity was the] hands on nature of this package, the fact that it's IT based.... students engaged very well with it and worked well independently when given background info."

(Irish secondary school teacher)

Example 14 - Using IT to teach/learn about space science

²⁰ Note that for the 'delayed' survey the statement language was more active e.g. "I have incorporated strategies..." instead of "I am familiar with strategies..."



A primary school teacher in rural India had previously only used traditional textbooks and lectures within her classroom. The local villagers work in agriculture, coconut farming and in the ancient oil extraction industry which uses wooden machines. Most of the children have parents who did not go to school. Inspired by the Space Awareness resources she decided to try some more inquiry-based approaches. The difference was dramatic: children who were usually shy joined in, and the pupils with special educational needs (described collectively as “late-bloomers”) were much more engaged. The activity also helped to overcome some previously held misconceptions. *“They asked more questions about how Jupiter can be bigger than our Earth? (until then they thought Earth should be the bigger planet, as it has so many big continents and oceans on it). [...] One thing I noticed in this session was that the late-bloomers found this activity interesting and they gave their full-prompt participation which is not [what happens] when we follow only the book-and-lecture method.”*

She also reported a dramatic shift in their classroom dynamics through the use of an interactive card game to encourage greater inclusivity. The teacher particularly appreciated the technique of allocating each student a different card, meaning that everyone could be involved. *“I noticed there was no hierarchy among the students as fast and slow learners. Because all the students had their card to read and had to answer the question on the card. So all the students in each group had their role to play.”*

(Indian primary school teacher)

Disadvantaged students

Example 16 - Developing teachers' and pupils' inquiry-based skills in rural India

Considering MOOC1, *Teaching with Space and Astronomy in your Classroom*, separately (as this was the main Space Awareness activity which focused explicitly on the majority of the intended *Skills* outcomes), there were clear gender-related patterns for many of these skills. In particular, females were statistically more likely to agree that they had developed skills relating to managing diversity ($p=0.046$) and gender balance ($p=0.034$), and also reported greater confidence and ability to use ICT in their teaching ($p=0.006$ and $p=0.019$ respectively). These findings suggest that MOOC1 (*Teaching with Space and Astronomy in the Classroom*) was particularly successful in supporting females in developing their pedagogic skills, competencies and confidence in incorporating space science within their everyday practice.

The most challenging intended outcomes within the *Skills* category related to the first and last statements: learning how to carry out scientific activities themselves and/or developing skills involved in space-related careers. In the main the difficulties arose because these are aspects that are difficult to ascertain using the data collection methods that were available to us: evidence of such skills development more commonly requires in situ observations and/or competency tests. However, multiple sources of anecdotal evidence suggested that the participating teachers both recognised and celebrated the skills that they and/or their students developed as a result of their involvement in Space Awareness (see Example 17 and Example 18).

As a result of their participation in one of the Space Awareness educational resources, one primary school teacher noted that her students *“experimented and researched solutions to problematic situations, they became active protagonists of the teaching-learning path”*.

(Italian primary school teacher)

In a similar situation at a secondary school in France, the teacher remarked on the success of a particular Space Awareness educational activity in creating a relevant context, and encouraging the students to take a more active role within the scientific investigation. *“Students needed to position themselves as a researcher and be an actor of their experience, so reason! Establishing a link between physical magnitudes such as mass and height energy is a difficult process for college students. This activity helps them to enter this type of approach, fundamental in experimental science.”*

(French secondary school teacher)

Example 17 - Students developing scientific or technical skills

“I really like the spread of skills that the activity allows you to develop. The activity allows for the development of literacy and numeracy skills to be utilised, appropriate to the age and stage of the children along with allowing the children to develop their scientific knowledge. I also like the creative element to this lesson. It allows all children, regardless of their ability to participate and access the content.”

(UK primary school teacher)

Example 18 - Evidence of skills development within the Space Awareness activities

5 Conclusions

This final section concentrates on identifying key strategic factors relating to the Space Awareness programme that are relevant to future similar initiatives. It is divided into three main themes: the successes achieved; the challenges encountered; and recommendations for the future.

5.1 Elements of success

Through synthesising the evidence gathered across all the various activities and resources produced within Space Awareness we have been able to identify five key factors which contributed to its success (Figure 10). Each of these factors is described briefly below.

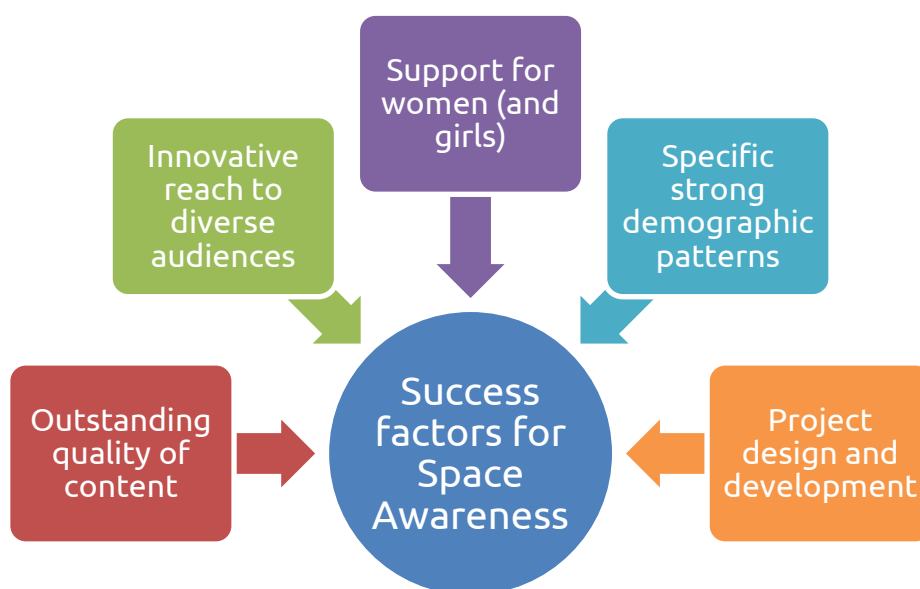


Figure 10 - Overview of the main factors contributing to the success of the Space Awareness project

Outstanding quality of content

There is no doubt that in general the resources and activities were perceived to be of very high quality, with teachers judging that they contained innovative content of direct relevance for use in the classroom (and beyond). For example, the MOOCs had an overall 30% completion rate, which is excellent compared to the wider standard of 5% for MOOCs generally (Jordan, 2014). Furthermore, almost 80% of respondents chose the maximum rating of "Strongly agree" when asked whether they would be interested in participating in a similar course again. There was also evidence of an "infectiousness" of being involved in Space Awareness, where participants continued on to other elements of the programme after a successful first encounter. Based on our data, specific aspects relating to the activities and resources that contributed to these successes were:

- Clear curriculum relevance

- Resources being provided in multimedia formats, especially videos
- The highly practical nature of the activities and workshop formats
- The provision of useful and innovative content, activities and ideas
- Being part of an international 'community' interested in space science

Innovative reach to diverse audiences

As outlined in section 2.1, Space Awareness achieved a very strong global presence, inspiring participation from 68 different countries, including all but one EU member state. This appears to have been mainly attributable to the existing strong connections with teachers and associated networks from within the project, as well as a spontaneous networking effect (e.g. uptake of resources beyond the project partners and nodes). Furthermore, the targeting of resources and marketing to teachers from outside traditional STEM subjects (such as geography, history, religion and more) was effective, and welcomed as a key success by participants (as well as workshop organisers). There was also clear evidence of Space Awareness being creatively utilised as an innovative language teaching resource, thereby reaching very different audiences to those normally involved in STEM education and outreach projects.

Successful support for women (and girls)

There is evidence that Space Awareness generally (and the MOOCs in particular) were successful in both attracting and supporting female teachers. 70% of MOOC participants were women, and although at the start of the course they demonstrated statistically significant lower levels of confidence in key knowledge areas, those differences were no longer present after the courses. Indeed, in some areas of knowledge the average female self-reported confidence in key course content surpassed those of the males. Furthermore, for both the face-to-face training courses as well as the MOOCs females provided higher course ratings and were more likely to be interested in participating in similar courses again. This suggests that they found the courses well-suited to their needs. Whilst no direct data collection was conducted with girls, there is also strong evidence of individuals achieving strong impacts (see Examples 3, 8, 10, 12 in section 4 to help illustrate this point).

Specific strong demographic patterns

Uptake of Space Awareness resources and activities within southern Europe (and some parts of eastern Europe) was remarkably strong. In part this is likely to be due to the presence of highly active and well-connected partners and nodes in Italy, Portugal, Greece, Romania and Bulgaria. It was also attributed to the perceived lack of high quality space-related educational resources available in those countries (especially translated into local languages)²¹. In addition, the teacher training provision (both online via the MOOCs, as well as face-to-face workshops hosted by the partners and nodes) achieved high levels of success in providing continuing professional development for experienced teachers (those who had previously worked 10+ years in the classroom) who might otherwise feel out of date regarding their subject knowledge and pedagogy.

²¹ By comparison, teachers in northern Europe reportedly feel that “you drown in resources” on the Internet, see the [Voices of Experience](#) report, section 3.3.1 for further details.

Project design and development

Finally, there were elements inherent to the design of the Space Awareness programme that undoubtedly contributed to its success. For example, the reach and quality of provision was greatly enhanced by the involvement of a network of enthusiastic, well connected national nodes. The strategic design of the programme content across school levels (primary/secondary but even preschool/kindergarten) and subject areas (STEM but also geography, history, religion, languages and other humanities) also contributed to its broad relevance and successful international uptake. The long-term perspective taken within the project planning (for example the focus on ensuring sustainability, the development of baseline data on European students' perspectives on space science, and the creation of a database of over 180 teacher contacts who are willing to be involved in future research on longitudinal impacts) all contribute to an assurance that the successes achieved within Space Awareness will extend far beyond the immediate boundaries of the project.

5.2 Challenges encountered

As with any large-scale project, Space Awareness did have to contend with certain barriers which prevented wider uptake, or limitations to achieving greater outcomes. This section reviews the main challenges encountered in order to inform the planning and development of future similar programmes. The main challenges are identified thematically in Figure 11 before being briefly described in turn.

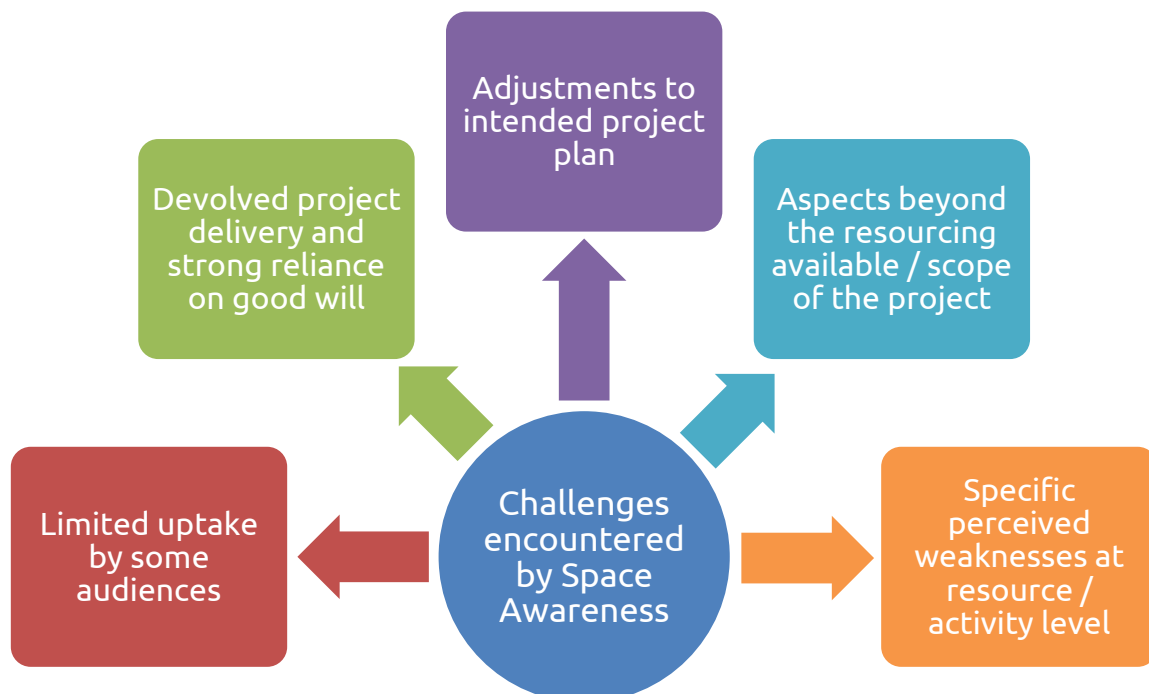


Figure 11 - Overview of the main challenges encountered during the Space Awareness project

Limited uptake by some audiences

There was noticeably low involvement of participants from northern and western Europe (apart from the teacher training sessions in Wales). Additionally, teachers with under six years' classroom experience were uncommon across the programme.

Devolved project delivery and strong reliance on good will

Space Awareness fundamentally relied on its network of partners and nodes to ensure successful delivery at national levels. As noted in section 5.1, where the delivery partners were enthusiastic and proactive this worked very well. However, some nodes were less active than others, or did not have as strong local connections with teachers and schools, which led to difficulties in their achieving their delivery targets.

The disconnect between resource production (managed by the central project team) and delivery (handled mainly by the nodes, though some project partners also had delivery responsibilities) was also reported to have created some tensions, including reducing the opportunities for formative feedback during resource development. Greater integration of feedback between production and delivery would be highly desirable in future.

The devolved nature of the project delivery also impacted on the evaluation data collection, as we relied mainly on the goodwill of the nodes to gather the necessary information. In turn, there were few incentives provided to teachers to complete the evaluation components, meaning that again we were reliant on their goodwill. As a result, teacher recruitment to participate in many of the evaluation processes (and especially testing the educational resources) proved very challenging in most countries. Furthermore, for both ethical and logistical reasons, partners and nodes could not be expected to work directly with school students and therefore direct information from one of our key target audiences was almost impossible to gather.

Adjustments to intended project plan

Various staff changes, though inevitable in a project of this magnitude, did delay certain elements, though in the main these issues were overcome. One notable issue reported within our data was disappointment regarding the late delivery of some resources (especially the materials relating to the *Journey of Ideas*) which meant that they could not be tested by teachers within this programme. The sensitive nature of the *Journey of Ideas* content meant that such delays were essential (to accommodate careful development of content and expert peer review prior to public release), however were unforeseen at the start of the programme.

Aspects beyond the resourcing available / scope of the project

The restricted curriculum content in many countries, especially at secondary school level, meant that some teachers were just not able to justify including Space Awareness within their classrooms. Similarly, many teachers asked for more explicit links to their specific national curriculum in order to make it easier (and less time consuming) for them to determine whether a resource was suitable to use. Whilst Space Awareness did undertake an initial curriculum mapping exercise to inform the development of all activities and resources, such detailed annotation of all the curriculum links across all relevant countries to all activities and resources produced was beyond the scope of the project.

Likewise, unfortunately, translation of resources proved challenging in some countries, leading to a restricted number of resources being available in all 12 project languages. There is definite evidence that this reduced uptake, especially for the educational resources, multimedia components, and MOOC content. Finally, delineation of the evaluation data according to the priority target audiences was limited due to challenges in collecting “sensitive” information in many countries (gender, minority status, socioeconomic background, see section 2.2).

Specific perceived weaknesses at resource / activity level

Though not described in detail here, the individual activity reports (see section 1.2 for the full list and weblinks) contain specific identified weaknesses. For example, though many respondents were positive about the course discussions in both the MOOCs and the face-to-face courses, it was noticeable that these received the lowest quality indicator ratings.

5.3 Recommendations

This last section of D7.2 draws together key insights synthesised from across the evaluation data analyses to inform the development of future similar programmes. The recommendations are divided thematically according to different levels of action: strategic policy development; and more detailed advice for education and outreach organisations intending to develop comparable initiatives.

Strategic policy advice

There is no doubt²² that many young people were greatly inspired by their involvement with the Space Awareness programme, and that it had a profound impact on their likely future aspirations and career-related decisions. In addition to pupil-related benefits, projects like Space Awareness play a fundamental role in ensuring teachers remain up-to-date, effective and enthusiastic, and have a wide influence long after the project ceases. Such projects should continue to be funded. In particular:

- 1) Space Awareness itself offers a unique opportunity for robust longitudinal follow-up due to the development of a baseline of pupils’ attitudes and experiences, as well as a cohort of 180+ educators located throughout Europe who have registered their contact details for potential follow-up work.
- 2) There appears to be a gap in current provision regarding offering international-level support to trainee and newly qualified teachers. Further opportunities to work with national-level teacher training / accreditation organisations would be particularly complementary to the audiences already reached within the programme.

Advice for future similar programmes

Table 6 summarises the key strategic recommendations relevant to anyone intending to develop a project similar to the Space Awareness programme. In addition, the [individual](#)

²² In addition to the very positive teacher feedback regarding the student-related intended outcomes, see also Examples 3, 4, 7, 9, 10, 11, 12, and 15 for specific cases of impacts at class or individual level.

[reports](#) associated with specific resources / activities (see section 1.2) also identified key recommendations at a more detailed level; please refer to those reports for further details.

<p style="text-align: center;">Ensuring wide uptake</p> <p>The following characteristics were identified as being likely to encourage wide uptake of the Space Awareness resources and activities (in roughly priority order):</p> <ul style="list-style-type: none"> • Being likely to engage student interest • Containing direct curriculum links • Focusing on hands-on and/or practical aspects • Including high quality images and well-researched scientific content, and/or successful explanation of an abstract or complex concept • Provision of clear supporting information, especially to assist those who are not specialists in space science topics (mainly to help answer common student questions). <p>From a broader perspective it is essential to implement a robust translation strategy to ensure uptake of resources in non-English speaking countries.</p> <p>Additionally, plan course timings carefully (both online and face-to-face), for example avoiding other commitments (exams, end of the school year etc.) or having a duration less than 90 minutes (as that proved insufficient to fully engage with the any practical activities).</p>	<p style="text-align: center;">Audience targeting opportunities</p> <p>In addition to the successes in reaching widespread and diverse audiences outlined in section 5.1, the following suggestions for additional audience targeting arose from within the evaluation data:</p> <ul style="list-style-type: none"> • Work with national teacher training / accreditation organisations to access teachers during their initial training. • Further consider users beyond formal classrooms, for example outreach organisations and extracurricular clubs. • Target teachers with management responsibility who can authorise whole school initiatives. • Continue to target and market space science content to participants from across the teaching spectrum, especially non-STEM specialists (especially geography teachers). • Participant feedback suggested that whilst the current suitability of content across both primary and secondary is welcome, further effort could be made to adapt the course content and materials to suit the needs of pre-school (kindergarten) teachers, as well as providing more activities for younger or lower ability students.
<p style="text-align: center;">Project management</p> <ul style="list-style-type: none"> • Continue the flexible model of delivery, where partners and nodes can adapt the content, focus and distribution of the resources and activities to best suit participants’ needs within the various countries involved. • Work with all partners and delivery organisations to develop a clear and integrated time plan for the production and evaluation of project activities and resources. In particular, incorporate a clear feedback phase (which also allows for delays in production) between resource development and use by teachers in the classroom which allows sufficient time for resources to be revised prior to the final versions being made public. • More opportunities for teachers / schools to collaborate internationally around space science content would be welcomed by both teachers and their pupils. • Feedback from participants also suggested that a broad invitation to teachers to rate and review material once it is made public would be welcome, for example a Trip Adviser style rating system. 	<p style="text-align: center;">Evaluation</p> <ul style="list-style-type: none"> • Continue to use diverse data collection methods (e.g. a combination of quantitative and qualitative analysis, as well as multi-stage approaches) to ensure temporal and methodological triangulation. • Work with European experts (such as DG Education, Youth, Sport and Culture) to identify suitable alternative proxies for collecting ‘sensitive’ data regarding student cohorts (especially minority status but also gender) across European countries. • Consider innovative tools which combine multiple project aims (e.g. dissemination and marketing as well as evaluation) such as the <i>Celebrating Excellent Space Science Teaching</i> competition. In Space Awareness this resulted in very rich examples of high quality impacts from the project, especially relating to disadvantaged communities and other priority target audiences. • Consider further incentives for teacher involvement in the evaluation processes – perhaps a prize draw, or release of further resources and materials once a feedback form has been returned.

Table 6 - Summary of key recommendations for future similar programmes

6 References

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7 Appendices

All of the individual activity reports and annexes (including data collection protocols and analyses where appropriate) have been provided [online](#). See section 1.2 for a short summary of the contents of each individual report.



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